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Progress in Searchlight Design

THE introduction of the concentrated filament incandescent lamp of the gas-filled type is ushering in a new era in the field of reflector lighting. It is well known that the nearer a light source approximates a point at the focus of a lens or reflecting mirror, the more powerful become the coalescing rays along the axis, and in some of the latest electric incandescent headlights and small searchlights for railroad, military and industrial service, this principle is taken advantage of with remarkable effect. With the expenditure of what are in reality only trifling amounts of electrical energy, properly equipped lamps are now coming from the manufacturers which are likely to set a new standard in special illumination, and it behooves the contractor seeking to light construction jobs at night economically along concentrated lines to look into the developments in this field.

Capitalizing Personality

THERE is something very human in Richard W. Sherman's account, on page 595, of the contractor who had made it a fixed policy never to bid on work under the direction of an engineer who wouldn't smoke a cigar, take a drink, or "cuss" upon due provocation. The contractor, on questioning, would probably admit that the presence or absence of these "vices"—provided the drinking were not to excess—would have no bearing on a man's engineering ability. Nevertheless, the case illustrates to what extent the contractor is concerned with the personality of the engineer. Contractors realize that profit or loss on their jobs depends to a large extent on the make-up of the engineer in charge. If he be harsh and arbitrary—a "specification fiend," as Mr. Sherman expresses it—contractors will avoid him and he will have to pay high prices for his work. If he be open minded and willing to hear the contractor's side of the case he will attract bidders and, with increased competition, will get his work done at less cost than his dictatorial brother. In other words, engineers can capitalize personality.

Spanish for Engineering Students

PRESS accounts report a great increase in the number of students enrolled in Spanish in high schools and colleges. The advantage of taking up a language absolutely necessary in carrying on relations with all South American countries except Brazil has been emphasized by business men recently, while the United States commissioner of education has issued a circular letter to high school principals urging upon them the introduction of courses in Spanish and Portuguese. It is not the purpose of this comment to urge engineering students to enroll in these courses. Those likely to take up the study will not, at this date, need to be urged. Question has been raised, however, as to the cultural value of Spanish as compared with German or French. This consideration does not seem, to this journal, to be an important factor in determining the language studies of the usual undergraduate engineering course. Undoubtedly both German and French are richer in the variety of their literature, but it is safe to say that the engineer whose sole knowledge of these languages comes from some preliminary high school work and one or two years in the technical course does not get beyond the commercial uses of the language. If that be the case the value of Spanish is probably equal to that of German or French. The disciplinary value is likely not below that of other modern languages, and the wealth of the literature need not enter into consideration.

"Snow-Fighting" in New York

A NEW phrase — "snow-fighting" — has been coined since John T. Fetherston assumed office as commissioner of the New York department of street cleaning. The old way of clearing the streets of snow was to wait, generally, until the storm had ceased, and then put to work every shoveler, driver, horse and cart that could be mustered into service. This winter a new plan will go into effect. Instead of waiting for the end of the storm, work will be begun during its early stages, and the expensive method of disposal by team haulage will be superseded very largely by one which involves the use of the city sewers for carrying the snow to the rivers which bound Manhattan Island. The scheme was outlined in a general way in Commissioner Fetherston's article which appeared in the Engineering Record of March 28 of this year, page 352. Since that time the details have been carefully worked out and are explained in a report printed on page 589 of this issue. This winter's plans contemplate snow work under three divisions—a snow-fighting force, a snow-removal force and a street-railway force. The most significant feature of the report is the comparative cost data for work by the snow-fighting and by the snow-removal methods. The estimated cost per million square yards cleared by snow-fighting, using the sewers as carriers and providing for the payment of a bonus to workers who do more than a specific task allotted to them, is $5,460 as against $22,438 by contract work. Certainly this estimate of savings should induce the board of estimate and apportionment to give the new plan a thorough trial. If these figures can be reached in actual practice, Commissioner Fetherston will have given another striking demonstration of the value of technically trained men as executive heads of municipal departments.

State Highway Bulletins

READERS of the Engineering Record will remember that the appearance of highway bulletins published by the road departments of Middle Western and Eastern States has been favorably commented upon in this journal. During the American Road Congress in Atlanta, the subject came up at various times in private conversation and the idea received in every case the hearty endorsement of the road officials who participated in the discussion. There is evidence in the States where they are published that the people are now more conversant with highway essentials than formerly, and that quick response can be expected from the people at large when a highway question of importance is at issue. It may be worth noting, for the benefit of those States not having bulletins, that the circulation of the publication issued by the Iowa highway department amounts to 20,000 per month. This circulation is among influential citizens, a fact assured by the method of compiling the list. The secretary of the highway department wrote to bankers throughout the State, asking each to suggest the names of three or four influential members of their communities who would be interested in the highway bulletin and would spread the gospel it preached. In this way a desirable circulation list was quickly compiled, and the results have fully justified the expectations of those who urged the establishment of the publication.

Aliens on Public Work

AS noted in this journal last week labor union interests in New York are threatening to tie up the work on the new subway system. This would be accomplished by having the Public Service Commission insist upon enforcing to the letter the law requiring that no aliens be employed on public work. The situation is a serious one and straight thinking and vigorous execution will be necessary if the work is to be continued, either by securing court action which will allow aliens to be employed until the matter can be finally settled or by replacing the foreigners by citizens. It may be argued that the contractors are at fault, because in taking the contracts they knew that, legally, only citizens could be employed. Nevertheless the law has been disregarded in the past and they were entitled, this journal believes, in proceeding on the theory that it would be disregarded in the future. If fault is to be found it is with those who failed to exercise the necessary jurisdiction in the past and who now are asked to insist on the observance to the letter of a law not previously enforced. Going back of this particular situation, however, the Engineering Record believes that the law itself is at fault. There should not be, in its judgment, a law confining public works to citizens only. There is no reason why public work should cost more than that done by private parties, and while it is well for the Government to set an example of right treatment of its employees the law in question goes unnecessarily far. It is on the books merely because a particular clique—the labor unions—have sufficient power at the ballot box to force the legislators into submission. It may be contended that the advocacy of the repeal of this law necessarily implies willingness to accept lower standards of living that we are accustomed to in this country. There is no logic, however, in that argument. If we do not want to lower standards of living, the remedy is not to forbid the employment of these men on public works, but to prohibit their entry into the country. If they come, they will compete for work with citizens and it matters not, so far as the general effect is concerned, whether they are engaged on public or private work.

Caring for Old Employees in Municipal Service

SOCIAL workers through their enthusiastic activities have forced upon the attention of all in recent years the necessity and desirability for studying the employment problem from its humanitarian point of view. The results of their propaganda are evident in the welfare work of large corporations—the sick benefit, accident and life insurance features—and the passage generally of workmen's compensation laws. Because of the prominence of organizations which have entered into this work, the impression might be gathered that such provisions are quite general, whereas investigation would show that such provisions were the exception rather than the rule. The smaller industries are far behind in their study of the needs of their employees.

It is quite certain, however, that the corporations have made as great progress as governmental organizations, though insanitary and dangerous occupations are exceptional in governmental service. Pension systems have long been the rule for members of police and fire departments. In some cities the school teachers are included but seldom does the pension system extend to other departments. There is need, however, for general consideration of this problem, as was emphasized in the annual report of the bureau of water of Philadelphia for 1913.

The oldest regularly paid employee in that bureau is 88 years old, while forty-eight employees, or about 4 per cent of the total number, are 70, or more, years of age. A much larger number are between 60 and 70. The present practice of the bureau is to continue an employee at full pay until long after he can perform his duties. The work, on the other hand, requires that most of the employees have reasonable physical vigor and activity, as well as skill and experience. The time comes when inactive men are not only of little help but frequently a positive detriment.

This is not the first time that attention has been called to this matter, Harrison P. Eddy, of Boston, entering into the subject at some length in a report made two or three years ago. It is hardly necessary to discuss the subject at length. Its mere statement is sufficient to point the need for investigation. Fortunately, there is much experience to be drawn upon from the police and fire pension funds. If municipal administration is to keep pace in the modern movement for proper treatment of employees, the matter of retiring incapacitated men or otherwise providing for them in a fair and equitable manner should be given careful consideration.

The Convict Camp

NO feature of Southern highway work seemed to be of greater interest to the Northern visitors at Atlanta week before last than the convict labor camps and the experience with the convicts on various classes of road work. Very few of the visitors left without visiting the camp nearest the city, and, judging by the opinions expressed, the Atlanta road congress should be the inspiration for the extension of the use of convict labor in the North.

Certainly, there seems no better method of employing these men than in the type of work where they compete only with the lowest grades of labor. This statement must be qualified as to the grades of labor, of course, when the higher types of paving surfaces are used, for in such work skill of no little order is required for satisfactory results. On earth, gravel and macadam roads, however, skilled supervision should permit the use of even the lowest grade of convict. For the more expensive and complicated types, great care will be needed in selecting from the convicts available. In the North, the system is not continuously applicable, owing to the impossibility of using the men for such work the year round. In the South there is less interruption, if any, through the colder months. The cheerfulness of the prisoners was generally commented on and also the fact that the housing conditions are much superior to what the average negro—the camp in question is a negro camp exclusively—is accustomed to.

One suggestion was made that might well be taken up by those in charge of camps both in the South and in the North. Inquiry indicates that the scheme has not been tried. After the convicts have had their evening meal, there is no occupation for them for the remainder of the evening. At the particular camp in question, a preacher appears at intervals and talks to the men for as much as two hours, a length of harangue that is not conducive to holding their attention. It was suggested by W. T. Beatty, of Chicago, that a reader be employed, as is the practice in Cuban cigar factories. By selecting the proper sort of fiction, and starting with short stories, requiring not over half an hour to read, it would be possible to give these men some diversion and gradually select the type of story that would have a moral influence. Ethical principles must be administered to these men in sugar-coated fashion, and undoubtedly, with the interest displayed in the South in the humanitarian conduct of these camps, there will be volunteers a-plenty to lay out an interesting course of reading and actually visit the camps to read to the men.

This would seem to be a desirable innovation, and it is hoped that some of the managers of convict camps will take up the suggestion and report thereon. It might be well to repeat again that the primary object should be to offer them some diversion through the long hours between meal time and the normal hour for retiring and not to preach. The inculcating of moral principles should be incidental.

Beginnings of Harvard-Technology Co-Operation

READERS familiar with the co-operative agreement between Harvard University and the Massachusetts Institute of Technology, which was ratified last January and summarized in these columns at that time, will be interested to learn that since the opening of the academic year in September a beginning has been made toward realizing the plans, and that eight Harvard professors are now giving regular instruction to institute students in Boston, fully a year in advance of the earliest probable opening of the new educational plant of Technology at Cambridge (which is described, with reference to its construction features, on page 578).

Under the terms of the agreement, professors in each institution have been made professors in the other. Sixteen teachers have thus been duly appointed by vote of the institute corporation, including two in civil engineering. These men retain their Harvard appointments, rights and privileges, their salaries being paid by Harvard through the institute bursary. Reciprocally, teachers of the same grades in the engineering and mining departments of Technology have been appointed by the Harvard corporation as professors and assistant professors of the same grade in Harvard.

All students enrolling under the new combination faculty will register as students of the institute and may present themselves as candidates for the institute degrees only or for the institute and Harvard master degrees. The details of the courses and degree requirements are not yet fully settled. The immediate advantage to the institute of this beginning of co-operation before the school moves to Cambridge is the addition of eight teachers to the faculty in a year when the increase in students has been much greater than usual. The new buildings at Cambridge have been planned to accommodate 2000 students, but there is a possibility that next year's enrollment may exhaust these provisions and perhaps require the temporary use of some Harvard plant. Harvard obtains the use of the institute buildings and engineering laboratories, with instruction accordingly, and Technology receives co-operative instruction and financial assistance. The working out of the plans will be of interest to all close observers of engineering education.

The Motor Vehicle in War

THE Pan-European war, if one may look ahead a bit in choosing its name, will, whatever its issue, be the turning point in motor-vehicle practice, certainly in Europe, probably all over the world. For carrying men and ammunition, dragging guns and supplies, and taking its place in the firing line as a mobile fortress, the motor vehicle has proved itself invaluable and an indispensable adjunct of modern war equipment. This indeed might reasonably be expected in view of the experiments which England, Germany, France and other powers had been making along this very line. It has been steadily proved by an increasing volume of evidence that a well-designed motor tractor will go into all sorts of places and perform apparently impossible feats in going over bad roads and worse country, but if the war continues for a considerable time, as there is every reason to expect, the motor vehicle will prove itself more than a valuable adjunct. It will certainly become almost the chief reliance of military and civil transportation, for the horse seems to suffer more than his expected share in the present conflict.

Perhaps nothing in the opening weeks of the war produced greater surprise than the enormous bodies of cavalry found to be at the disposal of Germany. To be sure those well posted in the details of German armament knew that for some years past the colossal preparations for just such a conflict as this had included the provision of a vast number of horses, yet their actual appearance on the field was so startling numerically as to astonish even the hardened campaigner. The Allies have also shown great strength in cavalry, and Russia has perhaps two cavalrymen for every one possessed by the combined forces of friend and foe alike, yet these cavalry horses, to say nothing of the riders, are being used up at a tremendous rate. A single charge against machine guns means that remounts will be demanded by the thousand, and none of the warring nations, unless possibly Russia, can have a reserve large enough for its men. The Allies can obtain from America and the Colonies a large amount of untrained stock, but Germany and Austria, thus far completely bottled up, have little chance of securing a suitable supply. Consequently, the whole transportation system of the Germans and Austrians, at least, will have to fall back upon motor vehicles. By the time the war is ended horses as beasts of burden in Europe will be pretty effectively thinned out and the work of the nations will depend on the motor.

Another effect of the war will be evident in increased knowledge of the design of motor vehicles for heavy traction purposes. The tremendous strains of a campaign will very soon sort out weak designs and indicate the most efficient. More than this, the motor car thus evolved must have a most catholic appetite for fuel. Petrol of every shade and grade, benzol, and alcohol, must be used in war as they can be obtained, so that in the outcome the veteran vehicles, at last quietly parked by their war-worn drivers, will represent the survival of the fittest. The certain outcome will be a use of motors for general transportation purposes to an extent hardly yet imagined by even the most enthusiastic builders.

Principles of Valuation Again

IN many respects the paper on "Fundamental Principles of Public Utility Valuation" presented last week before the American Society of Civil Engineers by John W. Alvord is one of the most clear-cut discussions of the subject yet published. Gifted with a simple and lucid style, Mr. Alvord has started with definitions, and has led logically to his principles, avoiding such pitfalls as highly theoretical discussions of depreciation. To those who hold that the courts have already irrevocably prescribed the basis of valuation, and who believe in one value for all purposes—determined by service rendered, the cost thereof and the public need for such service as much as by the investment or the cost to reproduce—he has presented the argument excellently. He has, also, indicated a use for the "other elements of value" which the Federal valuation act calls for, but which none have shown heretofore how to apply. There are three points, however, to which the Engineering Record believes attention should be directed, and on which it differs with Mr. Alvord: (1) His deference to the law as laid down by the courts, (2) his deduction of depreciation from reproduction cost new and (3) his failure to differentiate between monopolies and highly competitive utilities.

In the first part of his paper Mr. Alvord quotes numerous decisions to show that the courts have already fixed the course appraisers must follow, and asserts that deviation from this path must inevitably cause confusion and accomplish nothing. This journal does not believe that the courts have reached unanimity on all features of valuation nor that engineers need leave the interpretation of the mooted points entirely to lawyers and judges, who are hedged in by precedent. But even if the courts have said the last word on the law as it now stands, Congress can change the law. Therefore it is not conceded that because the courts have said that the "value now" must be used, we are permanently to evaluate properties on that basis. Moreover, we must hold fast to what is now good in the courts' decisions, for it is not safe, for example, to stand secure in the belief, because the courts have said that the "property" is more than so many rails and so many cars, that the question is finally settled. The engineering profession must do its part in educating public opinion and keeping it educated, or ground already gained may be lost.

On the second point of disagreement, that of deduction of depreciation, this journal has repeatedly expressed itself. Mr. Alvord has made the strongest case possible, and at first glance it would seem that to find the "value now" depreciation must be considered. But on Mr. Alvord's own argument that the "property" is the complete utility machine and not the mere sum of its physical parts, there is no depreciation, as far as the rate-payer is concerned, if the service being rendered is as good as if all the parts were brand new. This may require certain qualification when long-lived properties are considered. Mr. Alvord's experience is chiefly with waterworks, and the waterworks people, as this journal has pointed out, have in the past let their properties run down without adequate provision for renewals. Their physical plants, furthermore, have fewer and longer-lived units, and the cycle idea of renewal comes nearer to a reality. Therefore, a depreciation fund in some form is indispensable, and if there is none a diminishment of the rate-governing value will protect innocent investors from buying a broken-down property on the strength of past dividends. Even a badly run railroad can hardly come in this category, for renewals are under way constantly, keeping the line in operating fitness.

The third chief difference with Mr. Alvord is his application of one rule to monopolies—giving one kind of service, pretty much at their own terms, within a limited area, and competitive utilities giving many kinds of service to people in several States, and vying with other companies for their share of the business. Judge Prouty, director of valuation for the Interstate Commerce Commission, in his oft-quoted address before the National Chamber of Commerce (see Engineering Record of Feb. 24, 1914, page 228) emphasized the interdependence of railway rates. This element makes the railroad problem vastly different from that of the local monopoly. The figure the Government may determine as the value of the individual road can hardly be used to determine that road's rates, because between competitive points there must be, subject to differentials, one rate for all routes. Other complicating factors are furnished by local conditions which justify rates for shorter distances in no way comparable with the through rates. The sole use of the Federal valuation, as this journal sees it, as applied to the rate problem, is to establish a datum for all rates. With total cost of reproduction new, total operating expenses, total maintenance charges (including final renewals) and total gross income before it, the Interstate Commerce Commission will be in a position to judge whether rates should be revised horizontally upward or downward. For this purpose all of the railroads will have to be considered as one the country over. Of course individual readjustments will be possible, but the commission knows that it is hard to remove one thread without unraveling the whole rate fabric.

Construction Methods on New Concrete Buildings for M. I. T. in Cambridge

Five Mixing Plants Are Used for Delivering Concrete to Three and One-Quarter Acres of Structures—Systematic Field Tests of Concrete

At the new site for the Massachusetts Institute of Technology on the north bank of the Charles River in Cambridge, Mass., there are being constructed eleven buildings covering a ground area of 3¼ acres and involving 40,000 cu. yd. of concrete and 3600 tons of steel reinforcement. The lot upon which they are located extends for about 1500 ft. along the Charles River Basin and for an equal distance in a direction at right angles to the basin. The structural frame of the buildings is reinforced concrete with a steel frame for the dome of the library. The Stone & Webster Engineering Corporation, the constructing engineers, have about 900 men employed on the work at the present time, and expect to have all buildings under roof by Dec. 15.

PLAN OF DEVELOPMENT

The ultimate scheme for the development contemplates that the western half of the site will be occupied by the educational buildings, and the eastern half by the dormitories and such buildings and ground as will be used in the social and athletic activities of the students. The educational group is, in effect, one large building composed of several sections which will be arranged about the library as the central feature, the whole forming, in general outline, a large letter U with the points toward the Charles River. The hollow space of the U forms the large main court, and opening on either side of this, near the tips, and at right angles to the main court, are the minor courts.

The accompanying plan shows, in heavy lines, those buildings which are at present under construction, comprising the library, administration and principal engineering buildings, and in dotted lines buildings which will be undertaken at some future date, comprising the Pratt school of naval architecture, the Walker memorial, the gymnasium and dormitories.

The architectural design of the buildings is classical with pilastered walls. The facades on the front or river elevations, are to have pilasters two stories in height, the third story forming a frieze. The building further back, forming the lower sides and base of the U, will have a fourth, or attic story, and the library, located in the center of the base, will be five stories in height, and will be the most striking feature of the group, having a dome 124 ft. in diameter and rising approximately 150 ft. from the ground elevation.

While the structural frame of these buildings is of reinforced concrete, the principal elevations will be faced with Bedford limestone blocks, and the less prominent elevations will be veneered with face brick.

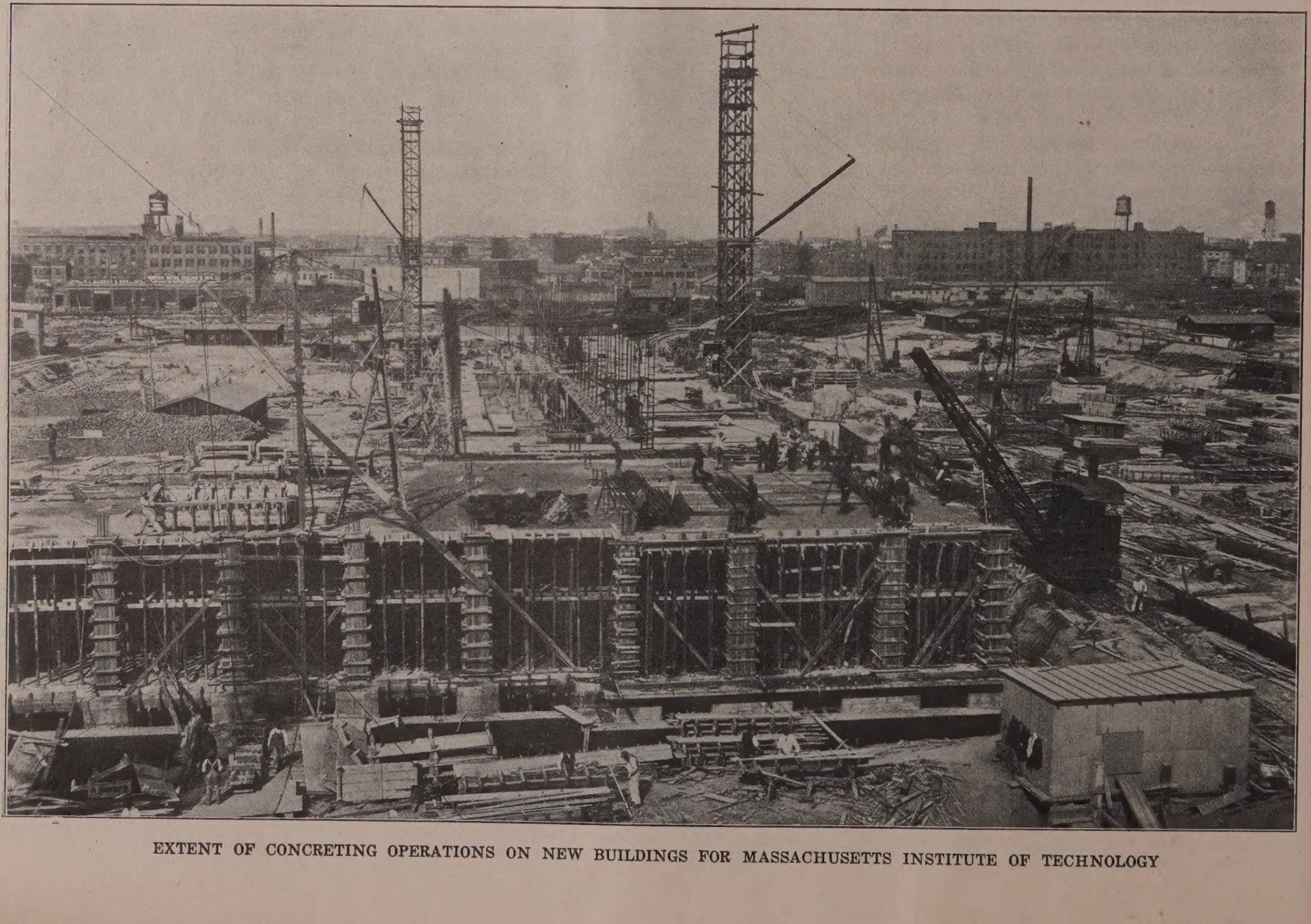
CONSTRUCTION ORGANIZATION

In order that the work might be pushed to the best advantage, and to introduce an element of competition, the construction organization has been divided into five sections. Each of these sections is practically a separate organization with its own foreman and timekeeper. Under this plan of administration each section foreman is impressed with a spirit of individual responsibility; and to a certain extent given an opportunity to use initiative in the conduct of the work of his section. The five section foremen are responsible to a general foreman, who, in turn, is responsible to the superintendent of construction.

In building work of any character, the various operations follow each other in more or less regular sequence. First comes the excavation and pile driving, then the concreting, followed by the brick and stone work, the electrical wiring, plumbing, heating, ventilating, building of partitions, roof covering and plastering; then follows the laying of finished floors and the wood trim.

PROGRESS CHART

In order that these various operations might be followed closely a definite progress chart was mapped out before the commencement of the work for each of the important items for each section. One of these charts is shown in the accompanying illustration, and the progress made by each section is noted on them weekly. From the individual progress charts, a condensed



EXTENT OF CONCRETING OPERATIONS ON NEW BUILDINGS FOR MASSACHUSETTS INSTITUTE OF TECHNOLOGY chart is compiled showing the progress of the work as a whole.

On the condensed chart the estimated progress is shown by a heavy horizontal line indicating the estimated dates of beginning and completing the work. Above this line is carried the percentage of work completed on a certain date that is indicated by a heavy vertical line; and below the estimated progress line is shown in red the revised schedule of time of commencement and completion. Interruptions are shown by breaks in this lower line. Weekly revisions are made on the chart, and explanations given for any changes and reasons stated when no changes are made.

DELIVERING CONCRETE AGGREGATES TO HOPPER UNDER FLOOR WHICH FEEDS SKIP HAULED UP INCLINE TO MIXER

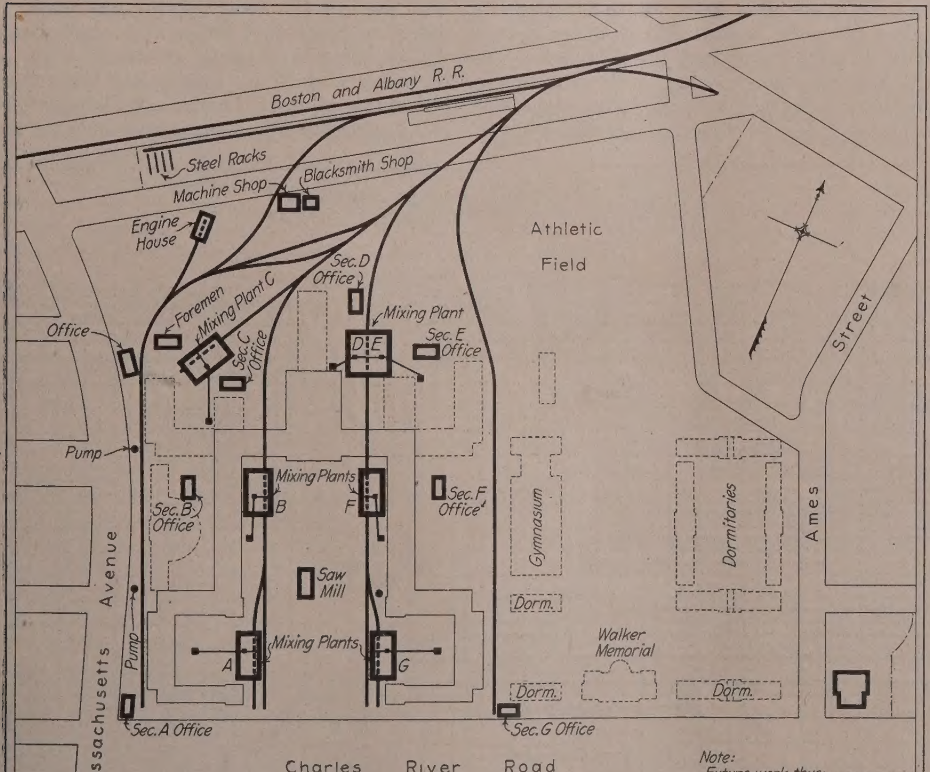
PILE FOUNDATIONS

The underlying material on the site of the new buildings is composed of fill, placed at various times, and is of a very unsatisfactory nature. Over the greater portion of the area this fill rests upon a coarse sand and gravel stratum, underlaid by a thick bed of clay which in turn rests upon rock at a depth of approximately 180 ft. On account of this soil condition it was considered advisable to support all structures on piles, and accordingly 23,000 timber piles have been driven.

A great deal of study was given by the engineers to the best type of foundations adaptable to the existing conditions, and it was finally decided, in view of the thinness of the upper sand and gravel stratum, that a comparatively few concentrated loads, such as would result from the use of concrete piles, were not advisable, but that a greater number of wood piles carrying smaller unit loads, evenly distributed, offered the best solution of the problem. No apprehension is entertained as to the permanence of these piles, owing to the nearness of the Charles River Basin, which keeps the ground water level comparatively near the surface and constantly at a grade which will insure continuous saturation of the wood piles, thus preventing decay.

LAYOUT OF CONSTRUCTION PLANT

In order that material might be delivered to the work with as little handling as possible a spur was constructed from the Boston & Albany Railroad tracks that run along the north side of the site, and from this spur standard-gage tracks were laid to various points. There are four main lines of construction track parallel to the longitudinal axis of the group of buildings that have spurs to the machine shop, the blacksmith shop, engine house, warehouse and the steel storage bins. There are 3 mi. of this construction track, and 800 ft. of trestle over which the cars are handled by one dinkey engine and the locomotive cranes.



LOCATION OF CONCRETE MIXING PLANTS AND TRACKS FOR DELIVERING MATERIALS

(Only five plants—those for sections A, B, D, F and G—are in use at present. The buildings in full lines are under construction; those in dotted lines are contemplated but not yet authorized.)

As the buildings are spread over a considerable area it was not practical to attempt to place all concrete from a large central plant, and the arrangement adopted was to construct five separate plants, one for each of the main sections. As the buildings are of reinforced-concrete construction none of the members is very large and the concrete work is divided into columns, beams, girders and floor slabs which are cast a story at a time. With a single large plant the mixed concrete would have to be carried a considerable distance, and would involve a much greater outlay of tracks, locomotives and derricks. With the smaller plants the mixed concrete is prepared close to the location where it is needed in the buildings. The tracks are run to the mixing plants that are located in the major court, through the two units which flank the library building on either side, at the elevation of the first floor. This necessitates the second floor of these two buildings being framed over the tracks and the panels on each side being left out until such time as it is convenient to discontinue the use of the mixing plants.

MIXING PLANTS

The mixing plants are so constructed that the sand and gravel bins are directly under the tracks which pass over them on short trestles at a height of about 16 ft. The cement sheds are located at one end of the bins, and immediately adjoining the track. A charging hopper is constructed in the floor of the bin platform, and by means of a slight excavation a Ransome skip car, running on an inclined track, can be placed immediately beneath it. The bins have a storage capacity of 300 cu. yd. of sand and 400 cu. yd. of gravel. The materials are placed by means of wheel-barrows into the charging hopper in the right proportions, and at the proper time, by means of a lever, the contents of the hopper are dumped directly into the skip car. The skip car is pulled by means of a cable connected with the drum of a hoisting engine up the inclined track to a platform above the mixer where it is automatically dumped into the mixer drum and the proper amount of water added.

Each batch from the mixer is discharged into a skip bucket and raised vertically to a hopper attached to the side of a wooden hoisting tower. From this hopper the concrete is conveyed, by inclined metal chutes, to a second hopper located on the forms near the place where the material is to be deposited. From this last hopper the concrete is conveyed in two-wheeled buggies and deposited in the forms.

Care is taken that the concrete is not deposited directly in the forms from the chutes, but first collected in a hopper. With the large amount of steel reinforcement in the work it is advisable to deposit the concrete in small batches, in order that it may be well tamped around the bars, rather than in continuous streams.

For the foundations and basement walls and piers, a mixture of 1 part Universal Portland cement, 2 parts sand and 4 parts gravel has been used. For the beams, columns and slabs a mixture of 1:1½:3 is used.

The columns in the buildings range from a maximum size of 30 in. square to a minimum of 12 in. square. The sections of the beams vary from 16 x 32 in. to 8 x 13 in. The floor slab thickness is from 5 to 8 in., and the slab span from 9 ft. to 15 ft. 6 in. in thickness. The longest beam span is 48 ft.

FORMS AND REINFORCEMENT

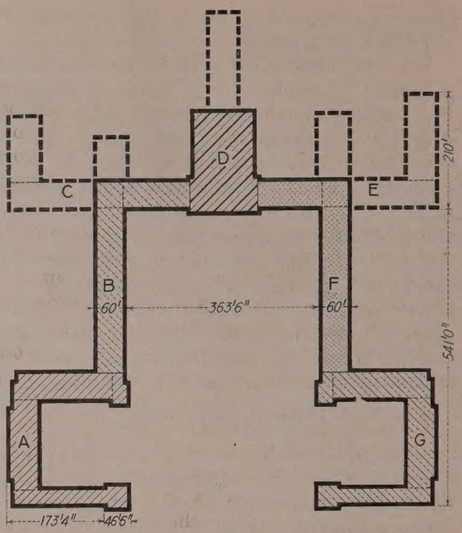
The forms for the Technology buildings are of wood and follow the general practice for this class of work. The timber is cut to size at a saw mill, located between the sides of the U as shown on the plan; and column and beam forms are made up on the ground and hoisted by booms attached to the concrete hoist towers. The column reinforcement is also fabricated on the ground, and is lowered into the forms as a unit and properly aligned. The form lumber is used on an average of two and one-half times. In stripping, the forms on the sides of the columns and beams are stripped first, usually about ten days after the concrete has been cast, and the bottom of the beams are left in place for a period of about three weeks.

All of the steel reinforcement consists of square twisted bars, delivered in mill lengths of 60 ft. and cut up and bent to the required shapes on the ground. The steel yard is equipped with shears having a capacity for cutting four ⅞ in. square bars at one operation. The greater portion of the bending is done by a machine bender, operated by an electric motor, but the stirrups and smaller bars are bent on steel tables by hand. Each batch of bars bent is tagged with a metal strip indicating the number of the building on which it is to be used and its exact location in the work.

FIELD TEST OF CONCRETE

One of the features of the construction work is the method of conducting the field test of the concrete. Each section, as previously noted, has its own concrete plant. Section A is equipped with a Lakewood mixer; sections B and C with a Marsh-Capron mixer; and the remaining sections with Ransome mixers; all having a capacity of ¾ cu. yd.

Samples of concrete are taken from each section four times a week, one sample being tested at the expiration of 14 days, and the other at 28 days. Both samples are taken from the same batch in order that a true relative value may be obtained. For the heavier concrete work, such as is in the footings, basement walls and floor slabs, the samples are taken directly from the concrete in place. Each test requires about eight ordinary shovelfuls, and the concrete is sampled in as many places in order to obtain a fair average mix. Two 14-quart galvanized iron pails are used for the purpose of holding the concrete thus secured, and it is poured from this pail into iron molds embedded in moist sand and resting on a ½-in. iron plate. The molds are kept in the northeasterly section of the site about 800 ft. from section A, and each day's maximum and minimum temperatures are recorded.

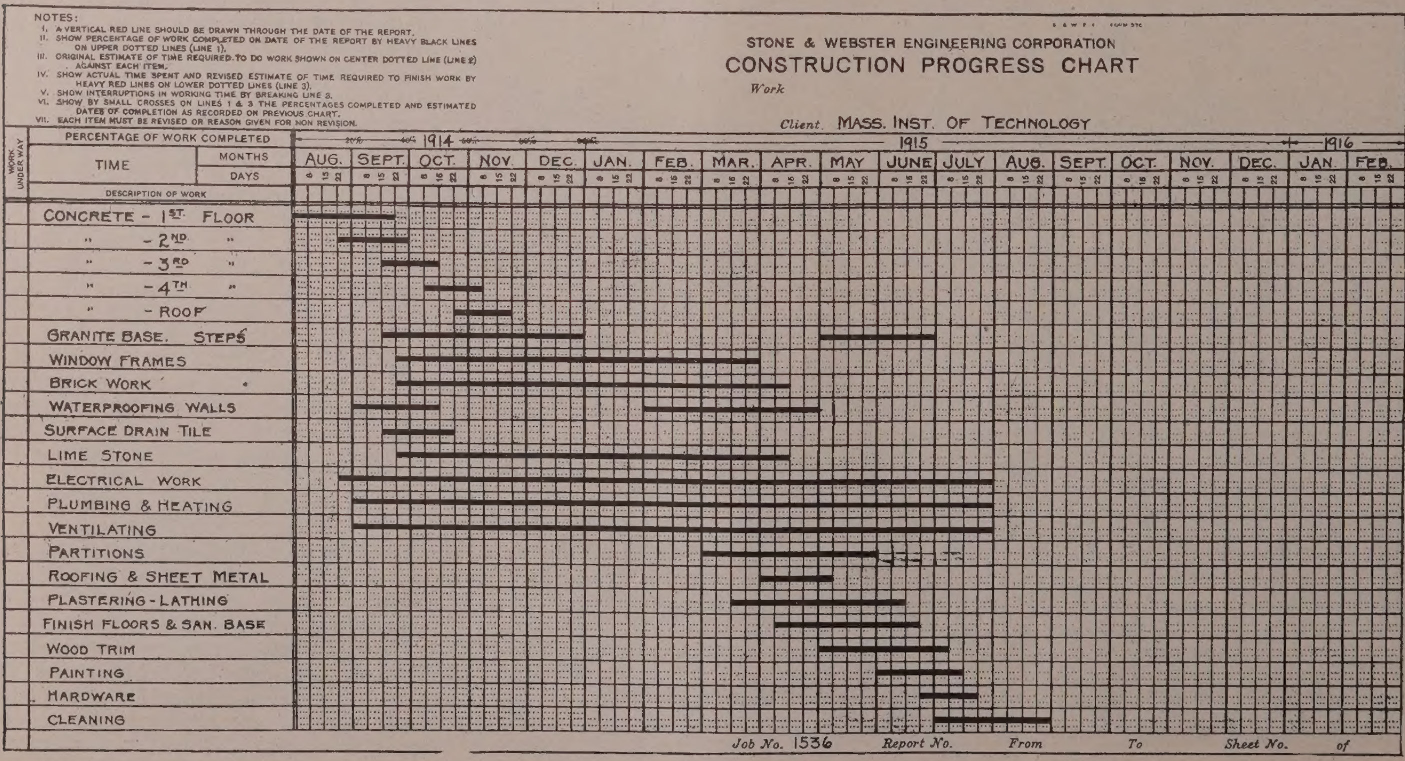


DIVISION OF WORK INTO FIVE SECTIONS

(Buildings in dotted lines not under construction at present.)

Before pouring the concrete into the molds, it is thoroughly remixed, as it is possible that separation of materials might occur while the specimens are being carried from the work to the molding yard.

For the heavier concrete work, such as was used in the footings, the aggregate is often as large as 2 in., and in such cases the samples are cast in cylinders 8 in. in diameter and 16 in. long. For the superstructure, columns, beams and slabs, where the aggregate has a maximum size of 1½

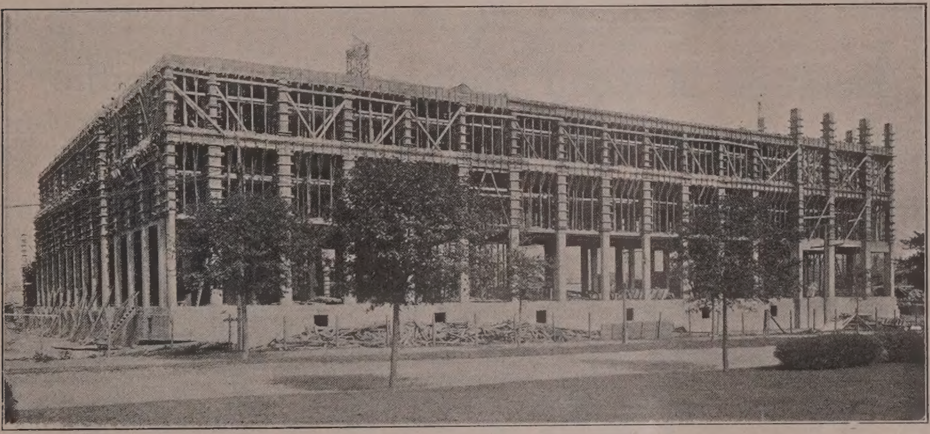


CONSTRUCTION PROGRESS CHART, SHOWING ESTIMATED TIMES OF BEGINNING AND COMPLETING DIFFERENT CLASSES OF WORK in., the test specimens are 6 x 6 x 12-in. prisms.

Each specimen is tamped in the molds with a 6-in. flat iron tamp, and only the same precautions are taken as are employed in the regular course for the work. Where it is not possible to take the samples directly from place, the concrete is taken from the buggies just before they are dumped. Each specimen is tamped once on each face and four times in the center, the tamp being held each time at an angle of 90 deg. to its position in the preceding operations.

TIME PERIODS

The whole operation of dumping from the pails into the molds and the tamping does not exceed 5 min., and just previous to the time the initial set is expected to take place the tops of the specimens are carefully troweled with an ordinary plaster trowel in order to provide a uniform bearing for testing. At the expiration of 48 hr. the molds are taken out of the wet sand, the specimens removed from the mold and reburied in moist sand, where they are left until the morning previous to the day arranged for the test. At this time they are removed and sent to the laboratory of the Massachusetts Institute of Technology for testing.



ONE CORNER OF THE TECHNOLOGY BUILDING GROUP ON CHARLES RIVER ROAD

The construction of the new technology buildings is being carried out by the Stone & Webster Engineering Corporation of Boston.

Bunk Wagon Used by Iowa Contractor

IN order to facilitate moving his construction camp outfit, a contractor of Iowa Falls, Iowa, has constructed a bunk wagon which can be loaded on a flat car for long journeys. The accompanying photograph portrays one of the contractor's two-bunk wagons, together with other equipment ready for travel.

BUNK WAGON LOADED ON CAR

Contract for Equipment for Chicago, Milwaukee & St. Paul Electrification

Twelve Electric Locomotives of Heaviest Type Ordered, Together with Line Material and Equipment for Four Substations

AS announced in the "Current News" of last week, the contract for the electrical equipment for the proposed electrified division of the Chicago, Milwaukee & St. Paul Railway in Montana was placed Nov. 13 with the General Electric Company. This covers twelve electric locomotives of the heaviest type, the overhead line material and the equipment for four substations.

This electrification is the first step in a scheme which when completed will greatly exceed in route mileage anything that has heretofore been attempted. The immediate program, as stated in an article in the Engineering Record of Jan. 3, page 29, calls for the electrification of 113 mi. of line between Three Forks and Deer Lodge, Mont., which, with sidings, make a total single-track mileage of 168. The final plans, however, include the extension of the electrified zone to cover the 440 mi. between Harlowtown, Mont., and Avery, Idaho, the whole foreshadowing the ultimate electrification of the main line to the Pacific Coast, a distance of 865 mi.

In authorizing the statement that the final contract for the work had been closed, C. A. Goodnow, assistant to the president of the Chicago, Milwaukee & St. Paul Railway, in charge of construction, said that field work on the overhead line would be started as soon as forces could be organized. Practically all of the poles are on the ground at the present time, and the overhead line material will be available when required. The contract calls for the delivery of the first substation equipment May 1, 1915, and the first locomotive Oct. 1, 1915. On receipt of the first locomotive it is planned to run an operating test, and if this is satisfactory the electrified division will be in full operation by Jan. 1, 1916.

The estimated cost of electrifying the 113-mi. section is $3,000,000 and that for the full 440 mi. is $12,000,000.

OVERHEAD CONSTRUCTION

Power for propulsion will be furnished at 3000 volts, direct current, instead of at 2400 volts as stated in the article referred to, and there will be four instead of five substations. The overhead construction, on which work has already been begun by the railroad company, is exactly similar to that used on the Butte, Anaconda & Pacific Railway, except that a double trolley wire will be used in order to provide greater collection area for the pantograph shoes. The contact wires will be supported by a flexible catenary construction that will be hung from mast arms on wooden poles, the single-pole bracket construction having been adopted because it affords a minimum obstruction to the view and also is less expensive than the use of span wires. Double poles with span wire, however, will be employed where there are two or more tracks as well as at the sharper curves.

A limited amount of feeder copper will be placed on the poles at the present time to minimize the voltage drop between substations. A high-tension transmission line will also be installed along the right of way, tying the substations together. This line will be erected and maintained by the railroad company, independently of the transmission lines from the hydroelectric company which is to supply the power, and will form a ring system to protect against shutdowns through line failures.

The prime power will be purchased from various hydroelectric plants of the Montana Power Company, and will be transmitted to the railway company's substations at 110,000 volts, three phase, sixty cycles. The price at which it will be furnished approximates ½ cent per kilowatt-hour, the power factor being limited to a variation of 20 per cent from unity and the monthly load factor being the equivalent of 60 per cent when based on the contract load. As planned at present, the load factor will easily be maintained by requiring the dispatcher to adjust train movements so as not to exceed the maximum amount of power covered by the power contract.

LOCOMOTIVES

The locomotives, of which twelve are to be included in the initial installation, will each consist of two half-units permanently coupled together to make an engine 112 ft. 8 in. long that weighs 260 tons and has 200 tons on drivers. The prominent feature of the design is the use of a separate motor twin-geared to each of the eight pairs of driving wheels. In the design the principle of "stretching out" the locomotive has been followed, minimizing the localization of vertical and horizontal blows on the track. The same principle was followed, although on a much smaller scale, in the case of the latest type of high-speed electric locomotive built by the General Electric Company for the New York Central & Hudson River Railroad, these engines having made a remarkably successful record for the past year in hauling the extremely heavy through passenger trains on that road.

The eight pairs of drivers for each complete locomotive are equally spaced at about 10-ft. intervals. Each half-unit has two articulated trucks with frames outside of the driving wheels, and this arrangement, together with the connection between the half-units themselves, provides a chassis composed of four trucks linked together by three permanent couplings. The driving-wheel trucks at the extreme ends of the com-

MAIN DIMENSIONS AND WEIGHTS OF LOCOMOTIVES

Length face to face of couplers	112 ft. 8 in.
Total wheel base	103 ft. 4 in.
Wheel base each half unit	46 ft. 7 in.
Minimum driving wheel base	5 ft. 0 in.
Total weight	260 tons
Weight on drivers	200 tons
Weight on each pair of driving wheels	25 tons
Weight on each bogie truck	30 tons
Diameter of driving wheels	52 in.
Capacity of locomotive—continuous rating	3000 hp
Capacity of locomotive—one-hour rating	3440 hp

plete unit have their frames extended to provide center-pin castings for four-wheeled bogie trucks, the extended framing carrying also the bumper beams and coupler at each end of the locomotive.

A summary of the general dimensions and weights of the locomotive is given in the accompanying table.

The drivers are 52 in. in diameter and are equalized in pairs on each side, so that each of the four driving-wheel trucks is independent. The drivers on the end trucks are not excepted, so that there is no cross equalization anywhere in the structure. The bogie trucks at the ends of the complete unit are of the standard locomotive type with 36-in. wheels on 6-ft. centers. Each one will transmit a 30-ton load to the truck wheels for guiding purposes, the truck center pin being 13 ft. 5 in. ahead of the nearest driving axle.

The cab extends practically the full length of the locomotive, the space between the two half-units being minimized to provide easy passageway from one end of the locomotive to the other. The height of the cab roof is only 13 ft. 10 in. above the rail exclusive of the housings for the ventilators, but the pantograph bases extend about 5 ft. above this, owing to the great height of the trolley wire, which will be maintained at an elevation of about 24 ft. above the rail. The cab for each half-unit will be supported at two points, one permitting rotation and the other a sliding movement, so that the chassis can weave about in accordance with the requirements of the track without affecting the cab.

MOTORS AND CONTROL

The eight motors for the complete locomotive will be of the General Electric 253-A type, and each will have a continuous rating of 375 hp and a one-hour rating of 430 hp. This will give the locomotive a continuous rating of 3000 hp and an hourly rating of 3440 hp. The drawbar pull effective for starting trains will approximate 80,000 lb. As previously mentioned, the motors will be twin-geared to the driving axles, that is to say, each armature shaft will carry a pinion on each end, and it is only in the matter of gear ratio that the passenger locomotives will differ from those used for hauling freight.

The motors will be insulated for 3000 volts, but permanently connected in pairs in series so that the voltage across each one will be 1500 when the locomotive is operating in full parallel on the 3000-volt trolley. The control will provide three running positions with the four pairs of motors connected in series, series-parallel or full-parallel, but the control system will include the novelty (for this country) of using regenerative braking control for holding trains on down grades. This will provide also for regenerative return of energy to the trolley wire on long down grades so that the presence of a train going down a mountain grade will be of assistance to another train coming up. This obviously will improve the load factor of the electrified division to a marked degree.

The motor equipment will enable locomotives in freight service to pull 2500-ton trains up 1-per cent grades at a speed of 16 mi. per hour, or, when two locomotives are used on a train, will provide power enough to pull 2500 tons up a 2-per cent grade. However, the plan of operation includes the general use of a locomotive at each end of trains on ascending grades, there being one 2-per cent grade 20 mi. long and two 1-per cent grades approximately 35 mi. long on the electrified section. On descending grades only the locomotive at the head end will do the regenerative braking. The locomotives in passenger service will be called upon to haul trailing loads of 800 tons at a speed of 60 mi. per hour on the level.

Collection of the large drafts of current (ranging from 1500 to 2000 amp at 3000 volts) that will be required for the service at times will be effected through the use of two pantographs of the "pan" type on each complete locomotive. As a provision against the possibility of injurious arcing, however, and to supply an ample factor of surplus capacity the previously mentioned use of a double trolley wire was considered desirable. This secures flexibility and gives a greater area of collection, the maximum draft of current per pantograph contact being thus reduced to something in the vicinity of 500 amp.

All of the plans for the electrification project have been in charge of C. A. Goodnow, assistant to the president, Chicago, Milwaukee & St. Paul Railroad, and R. Beeuwkes, electrical engineer, and the work of construction that is soon to begin will be under their direction. In general, all of the erection will be done by the railroad company, including the installation of the overhead lines, the construction of the substations, and the preliminary operation during the future period of transition from the use of steam to that of electricity.

Relation of Road Maintenance to Traffic

Abstract of Paper Read at Fourth American Road Congress at Atlanta, Georgia, Nov. 11 by Col. William D. Sohier, Chairman, Massachusetts Highway Commission

STUDIES in road maintenance in Massachusetts have attracted much attention in recent years. In an address before the Fourth American Road Congress, held in Atlanta, Ga., Nov. 9-14, Col. William D. Sohier, chairman of the Massachusetts State Highway Commission, dealt at length with these studies, comparing them with observations of English and French practice. His remarks at the preceding Congress, held in Detroit in 1913, included many of these European impressions and were published in part in the Engineering Record of Oct. 11, 1913, page 405. What Colonel Sohier had to say at the Atlanta meeting with regard to the influence of the characteristics of traffic—volume, weight of units, relative number of rubber-tired and steel-tired vehicles, and the like—on the cost of maintenance, is abstracted in the following. The remarks cover comprehensive traffic and repair studies completed since 1894, when the Massachusetts commission began building roads.

H. T. Wakeland, engineer of the County of Middlesex, just out of London, has given some very careful figures showing damage caused to roads by motorbuses weighing about 6 tons loaded. He took certain roads which had heavy traffic and gave the cost of maintenance, not including watering or cleaning, for macadam roads for three years previous to the motorbus traffic, and the cost per square yard for the year 1912-13. These are given in Table 1.

The average cost of maintenance for three years before the motorbus came in was about 12 cents per square yard per annum. Since then the cost has increased to more than 25 cents. The maintenance cost to carry 1 ton 1 mi. in 1911-12 was 1.2 cents. When the motorbus was put on, the maintenance cost was raised to 1.8 cents per ton-mile. Mr. Wakeland's opinion is that this increase was practically all due to the motorbus. The increased cost of upkeep has been found to be about 4 cents per car-mile, or 2/3 cent per ton-mile in the case of a rubber-tired motorbus. In many cases the macadam surface has been practically destroyed by bus traffic on hard rubber tires. These macadam roads were in standard condition prior to the inauguration of the motorbus traffic, fully able to carry ordinary traffic. Road authorities, Mr. Wakeland believes, should be authorized to direct which roads shall and which shall not be used by motor vehicles. He states, as do the other county engineers in England, that a license fee of $50 a year for motor trucks is entirely insufficient to pay for the increased cost of maintenance caused by the use of the trucks on the roads.

TABLE 1—INFLUENCE OF MOTORBUS TRAFFIC ON MAINTENANCE COST OF ENGLISH ROADS

Cost in cents per yard per annum for each of ten roads for three years previous to motorbus traffic.	Cost in cents per yard for 1912-13.
13.5	25.8
11.2	33.1
14.1	41.9
15.6	16.9
9.1	15.4
8.7	15.1
5.9	16.8
5.1	11.1
21.5	36.4
16.9	42.9

DOMINANT TRAFFIC ELEMENTS

A very useful paper on construction and maintenance was published in connection with the International Road Congress in 1913, presenting the experiences of five of the most competent road engineers in England. It gives the weight in traffic in tons carried 1 mi. for 1 cent of maintenance cost, and appears here in Table 2, which also includes data for two Massachusetts roads. All roads named are waterbound macadam, with or without surface tar.

The English ton is used, but the pennies are changed to cents. The table shows that the maintenance cost on waterbound macadam roads to carry 1 ton 1 mi. varied from about ¼ cent to 1½ cents, illustrating very well the necessity of the traffic census showing the class and character of the vehicles which use the road rather than any formula which merely uses an assumed weight for each class of vehicle.

We have found in Massachusetts that the largest cost of upkeep on macadam roads would come from two causes. Heavy automobile travel would disintegrate a plain gravel or macadam road very soon. This could be prevented by the use of bituminous material on the surface, provided team traffic was not so heavy that it would quickly wear out the binder. A large number of 3-ton teams would quickly wear out the binder. Further, a very large number of heavy loads carried on narrow tires would wear a macadam road relatively quickly. Some wore from ½ to 1 in. a year, whereas when a bituminous macadam road with a 3-in. top was constructed the wear was very much reduced.

The necessity for knowing the kind of travel is well shown by English experience. On a road in one county it cost 1.42 cents to carry a ton a mile, and on another macadam road in the same county it cost 0.13 cent. It appears that when the cost of maintenance exceeded 2/3 cent per ton-mile it was more economical to use granite block on a concrete base. The cost for annual maintenance of a 6-in. block on a concrete base near the docks in Liverpool has been 0.058 cent a ton-mile.

MASSACHUSETTS TRAFFIC AND COST DATA

The Massachusetts traffic and cost figures given in Table 3 illustrate how misleading statistics are if read without adequate knowledge of actual conditions. The variations depend on inequalities in traffic and weight, toughness of stone, whether the road has been resurfaced or not, quality of bituminous materials, and proper or improper use of materials.

The Ashby road, with high cost of maintenance and small traffic, can be compared with that through Hamilton, which has more traffic and a small cost for maintenance per ton. The former was built of local stone—comparatively soft—and resurfaced with the same stone when about twelve years old, 30 tons being used per 100 ft. It is a country road. It had an application of ¼ gal, of cold asphaltic oil per yard in 1913. The stone had worn down practically ¼ in. per year.

The Hamilton road was built of trap-rock macadam on a main through route. When the road was eight years old the stone had worn down about 3 in. and the road needed resurfacing. In 1907 ½ gal. per yard of the heaviest asphaltic oil applied cold was spread upon the road and properly covered with pea stone and gravel. This treatment was repeated for two years. Then ¼ gal. of heavy hot asphaltic oil was sprayed upon the road and properly covered; this treatment has been repeated once. The road has been kept patched, and sanded when necessary. It is in better condition to-day than in 1907.

TABLE 3—TRAFFIC AND COST DATA FOR MASSACHUSETTS STATE HIGHWAYS

Town	Amount of traffic: Total tonnage per day	Amount of traffic: Total tonnage per year (300 days)	Repairs and maintenance cost: Per mile per year	Repairs and maintenance cost: Per ton-mile per year, cents	Period, years	Character of traffic: Run-abouts, automobiles, touring cars and wagons	Character of traffic: Trucks		Number of horse-drawn vehicles per day: Single-horse, Light	Single-horse, Heavy	Two or more, Light	Two or more, Heavy
Ashby	271	81,150	$266	0.38	18	14	65	4	70	16	5	14
Beverly	1,618	485,280	1,104	0.23	15	60	278	8	66	46	4	12
Hamilton	1,199	359,730	200	0.06	15	86	334	31	75	39	2	27
Lynn	3,468	1,040,430	1,081	0.10	9	194	1,365	13	28	19	1	14
Medford-Somerville	1,332	399,570	1,031	0.26	6	44	121	49	47	198	2	183
*Milton	1,140	342,210	592	0.17	14	15	50	0	30	77	2	88
Saugus	1,022	306,660	1,334	0.44	14	15	58	78	25	190	3	65
Shrewsbury	1,305	391,500	510	0.13	17	76	407	17	64	60	4	36
Truro	186	55,770	143	0.25	17	7	63	1	15	14	1	3
Weston	1,918	575,280	1,040	0.18	15	115	533	30	167	98	5	59

*1909 report used; results increased 70 per cent to correspond with 1912 report. Weight of double heavy teams increased from 2.46 to 5 tons.

The Beverly road, with a high cost of maintenance per ton mile, can be compared with the Lynn road, with a small cost. Both are on main routes and were trap-rock macadam. The former has a large number of heavy ice teams on 3-in. tires. It was resurfaced with trap rock when the road was eight or nine years old, 30 tons of stone being used per 100 ft. This had worn 1/3 in. a year. In 1910 it was coated with ½ gal. of hot asphaltic oil per square yard, covered with pea stone and dust. This failed in one month under the heavy ice teaming, although a surface built with the same material and by the same methods on the next 20 mi. has stood ever since with constant patching and treatment with ¼ gal. per square yard of the same oil sprayed on the road 8 ft. in width.

For the next four years the Beverly road was maintained (except where it was resurfaced) by the use of ¼ gal. of cold oil per square yard, two applications being used the first year and one each year since. One-third of the road was resurfaced in 1913 with an asphaltic macadam 2 in. deep at a cost of $1.20 per square yard, 2½-in. stone being used because of the heavy teams and trucks.

A trap-rock macadam highway at Lynn connects with a parkway where only pleasure vehicles are admitted, except on local business. In 1907 ½ gal. per yard of hot refined tar was sprayed upon the road, and kept covered with pea stone and dust. It was constantly patched with tar and chips. It has been recoated twice and is in excellent condition, but 90 per cent of the travel is motor; there are a few teams, usually light.

The Medford-Somerville road is a trap-rock macadam, built with the 2½-in. stone on top. It is 28 ft. wide, bearing heavy city teaming and passing a stone quarry crushing from 100 to 300 tons a day. This road has never been in good condition since it was two years old. It always has some depressions, although it has been daily patched and all depressions have been filled with trap rock. It has always been muddy. A portion beyond the stone quarries was resurfaced with tar macadam this year. The whole road needs it. It has been treated with tar—a part with heavy tar. A portion had three ¼-gal. coats of hot refined tar, covered with pea stone, in one year. It failed and was never in good condition, and we are in doubt whether to reconstruct with granite block on a concrete base, with concrete, or to try an asphaltic macadam.

AVOID COLD WEATHER

At Milton is a road of the same character with many heavy granite teams going over it. The cost has been high because the trap rock wore very rapidly under the heavy concentrated loads on iron tires. The Saugus road is trap-rock macadam on a through route with a great deal of heavy traffic, both teams and trucks. The stone wore more than ½ in. in a year. It needed constant patch-

TABLE 2—TRAFFIC IN TONS CARRIED 1 MILE FOR 1 CENT OF MAINTENANCE COST

County	Traffic in tons: Per day	Traffic in tons: Per annum	Average cost per mile per annum	Long tons carried 1 mi. for 1 cent	Cost of maintenance in cents per ton-mile
Norfolk	39	14,200	$206.25	0.70	1.42
Norfolk	96	35,000	60.00	4.50	0.22
Warwick	185	67,500	430.00	1.60	0.62
Warwick	239	87,200	635.00	1.45	0.68
Warwick	242	88,300	430.00	2.15	0.46
*Kent	348	126,700	1,495.00	0.85	1.18
Norfolk	359	131,000	366.25	3.70	0.26
Norfolk	385	140,500	281.25	5.20	0.192
Norfolk	390	142,300	275.00	5.35	0.186
Warwick	451	164,600	635.00	2.70	0.36
Norfolk	504	184,000	251.25	7.55	0.132
Kent	528	192,100	1,740.00	1.10	0.90
Warwick	609	222,000	1,345.00	1.70	0.58
Warwick	734	268,000	2,095.00	1.35	0.74
Warwick	736	268,600	670.00	3.95	0.254
*Kent	796	289,800	960.00	3.15	0.32
E. Sussex	984	359,000	1,665.00	2.20	0.44
Norfolk	1,057	386,000	1,090.00	3.65	0.26
Kent	3,030	1,102,810	10,500.00	1.05	0.94
*Kent	3,030	1,102,810	8,960.00	1.25	0.80
Surrey	5,694	2,078,300	5,160.00	4.20	0.24
*Surrey	5,694	2,078,300	3,020.00	7.15	0.14
Comparison with two Massachusetts roads					
Beverly	2,898	1,058,430	3,257.00	6.50	0.37
Weston	1,920	699,924	1,993.00	7.02	0.28

*Surface tarred.

TABLE 4—TRAFFIC VALUES OF GRAVEL AND WATERBOUND MACADAM ROADS

	Average Daily Traffic: Light teams, carriages, wagons	Heavy teams, one-horse	Heavy teams, two or more horses	Automobiles
A good gravel road will wear reasonably well and be economical with	50-75	25-30	10-15	50 to 75
It needs to be oiled with	50-75	25-30	10-15	Over 75
Oiled gravel, fairly good heavy cold oil, ½ gal. per square yard, applied annually, with	75-100	30-50	20	500 to 700 or more
Waterbound macadam will stand with	175-200	175-200	60-80	Not over 50 at high speed
Cold oil or tar will prove serviceable on such macadam with	175-200	175-200	60-80	50-500
Macadam will then stand, but the stone wears, of course, with	175-200	175-200	60-80	500 or more
Waterbound macadam with hot asphaltic oil blanket will be economical with	100-150	50-75	25-30	1500 and more with fewer teams
and stand at least	......	......	.....	50 trucks
but will crumble and perhaps fail with more than (on narrow tires, ice, farm and wood teams, etc.)	150	75	30	......
Waterbound macadam with a good surface coating of tar (½ gal. per square yard) will stand with	100-150	50-75	25-30	1500 or more
but requires to be recoated annually with ¼ gal. of tar per square yard.				

ing with additional stone and was never in excellent condition except when recently resurfaced. New stone to a depth of 2 or 3 in. was applied every four or five years. In 1910 the road was resurfaced with 3 in. of asphaltic macadam at a cost of about $1 per square yard. This has stood ever since but has needed some patching. A portion built in the fall when it was cold failed. No bituminous work should be done in cold weather and a temperature above 60 deg. is vastly better than one under 40.

A through route passes Shrewsbury. Too much heavy hot oil was used on it before we understood how to use oil. One-half gallon per square yard was applied in each of two successive years. It rolled, rutted and was always in bad condition. It has cost a good deal to remove surplus oil, smooth off the bunches and rolls and keep it patched.

The Truro road carries little traffic. It was built 12 ft. wide of 4 in. of broken stone on sand, the stone being bound with clay. This was an experiment and proved a failure. It was constantly raveling and needed more stone. It was widened to 16 ft., new stone was added and rolled in, and the road was coated with light oil in 1912 and 1913; it is now in good condition.

A macadam road on a through route passes Weston. Refined tar was applied in 1907 and the road was oiled with hot oil in 1909 and 1910. It was maintained with patching until 1912, when a portion was resurfaced with 2 in. of bituminous macadam. Broken 2½-in. trap rock was rolled hard and from 1¾ to 2 gal, of a good grade of asphalt to the square yard were sprayed in under pressure. This surface was covered with the smaller stone and rolled, and on some portions of the road a surface application of from 1/3 to ½ gal. per yard was sprayed, properly covered with pea stone and rolled. This cost from 90 cents to $1 per square yard. The road is in most excellent condition and we expect to have it wear ten or fifteen years with practically no patching, although we may have to renew the surface coating by spraying every three or five years. One road of this kind, six years old, has not needed a single patch as yet.

COMPARATIVE TRAFFIC VALUES

Table 4 presents the average daily traffic that may be borne by gravel or waterbound macadam roads, with various surface treatments. The standard road is 5 or 6 in. thick and 15 ft. wide, with 3-ft. gravel shoulders. The table has been changed somewhat as the result of experience since 1912, when a similar table was published, and now represents the Massachusetts department's observation at more than 150 points. It assumes that all road surfaces are kept constantly patched, that before applying bitumen the road surface is cleaned and patched, and that the bitumen is covered with pea stone and sand or gravel, and kept covered so that it never picks up.

Results have been obtained on many miles of road where we have used a good grade of asphaltic oil, either hot or cold, heavy or light, or a good grade of refined tar. We have had many failures on short sections of road where a non-asphaltic oil was used or a poor grade of oil or tar, and many proprietary so-called dust-layers have failed. Roads that failed have been resurfaced or retreated, but the results are not tabulated in the table.

Certain exceptions should be noted. Army manœuvres, especially large bodies of cavalry and artillery, will rapidly destroy any bituminous blanket surface. A blanket coat of hot oil on macadam will carry a much larger number of teams if there are two or three automobiles on pneumatic tires to each team to keep the bituminous surface rolled down.

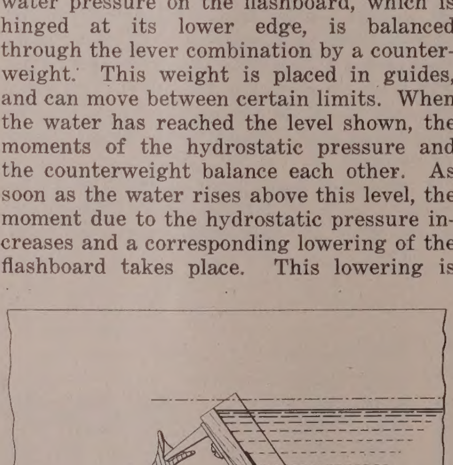
A very few teams on narrow tires, however, or a few very heavy teams every day, will destroy the surface if the load is heavy enough to shear down entirely through the surface to the stone. Light oil or coal tar will then be more serviceable, laying the dust while the stone takes the wear.

We have maintained a few miles of road in reasonably satisfactory condition with annual applications of a coal tar or water-gas tar. They have required ½ gal. per square yard annually, and the results have been about the same and certainly no better than where we have applied two ¼-gal. coats per square yard of light asphaltic oil the first year and ¼ gal. per square yard each succeeding year. The cost for the tar has been more.

Invariably we clean and patch the road first and cover the bituminous material sufficiently to prevent its picking up. We have sometimes tried dispensing with the cleaning and covering but shall not repeat that expensive experiment. We can usually have the light asphaltic oil sprayed upon the roads by motor trucks for from 1.2 cents to 1.5 cents per square yard, using 1/5 to ¼ gal. per square yard. Cleaning, patching and covering cost about the same.

Automatic Dam Crest with Movable Counterweight

A MODIFIED type of automatic flashboard for dams, invented by W. H. Itte and J. Martin, of Zurich, Switzerland, is shown in the accompanying drawing. The water pressure on the flashboard, which is hinged at its lower edge, is balanced through the lever combination by a counterweight. This weight is placed in guides, and can move between certain limits. When the water has reached the level shown, the moments of the hydrostatic pressure and the counterweight balance each other. As soon as the water rises above this level, the moment due to the hydrostatic pressure increases and a corresponding lowering of the flashboard takes place. This lowering is gradual and proportional to the increase in water pressure until the lower arm of the lever gets into a position permitting the counterweight to roll in its guides. As this decreases its moment the flashboard suddenly takes the position indicated by the broken lines. Because of this feature a considerable fall in water level must take place, before the moment due to the hydrostatic pressure becomes less than that of the counterweight. Another advantage is that when the lever again reaches a position permitting the counterweight to move, the increase in moment will be sudden and the flashboard will rise quickly. By adjusting the dowel by which the gate is supported on the lever, the water levels under which the flashboard rises and falls can be regulated.



NOVEL AUTOMATIC DAM CREST

Phenomenal Run of Precise Leveling in Northwest

John H. Peters, of U. S. Coast and Geodetic Survey, Covers 148.3 Miles in Month of October, Establishing New Record on This Work

A PHENOMENAL run of precise levels was made during October by John H. Peters, assistant, U. S. Coast and Geodetic Survey, while operating in the States of Montana, Idaho and Washington. In a communication to the Engineering Record F. W. Perkins, acting superintendent of the Survey, gives the following details regarding the performance:

The progress made along the line of levels by Mr. Peters was 148.3 mi. during the month. No work was done on Sundays. Each mile of this line was run over at least twice and some of it, about 10 per cent, was leveled over more than twice. The total amount of single line of leveling was 327.7 mi. There were 3156 set-ups of the instrument and the actual time of leveling was about 161 hr., the average time per day being 6.6 hr. The average length of sight was 272 ft., the maximum running for any one day was 20.3 mi. made in 7 hr. on Oct. 12, 1914.

Mr. Peters' October run exceeds by 28.3 mi. the running made by him in July, 1914, which, in turn, exceded the previous record of 112 mi. established by Assistant James B. Miller of the U. S. Coast and Geodetic Survey in 1905.

The means of transportation used by Mr. Peters' party was one hand and one motor velocipede car, and the instrument was the Coast and Geodetic Survey precise level, which is described in detail in Appendix 3 of the Report for 1903 of the Coast and Geodetic Survey. The organization and management of a precise leveling party are described fully on pages 14-17 of Special Publication No. 18 of this Survey. The instructions under which the leveling of the Coast and Geodetic Survey is done are given on pages 8-12 of the last mentioned publication.

It is noteworthy, Mr. Perkins states, that the amount of leveling accomplished by Mr. Peters is the result of the methods and instruments used, rather than long hours. There were five men in the party and the total expenses for the month were $675.

"LE GÉNIE CIVIL," one of the leading French technical papers, announces that so many members of its staff are at the front that it will be necessary to issue the paper bi-monthly instead of weekly as heretofore.

Some Recent Tests of High-Power High-Speed Water Turbines

Investigations at Holyoke Flume Show That Wheels for Very High Speed-Power Values Can Be Designed with Good Efficiencies

By S. J. ZOWSKI
Professor of Mechanical Engineering, University of Michigan, Ann Arbor, Mich.

DURING the last few years a large number of tests have been made in the Holyoke testing flume on wheels of high "type characteristics,"[*] that is, on wheels of high speed and power values. The results of some of these tests are noteworthy as demonstrating a remarkable progress in the art of designing and building these wheel types and as proving that some of the current adverse opinions regarding the possibility of such progress and of further important developments in the field of such wheels were erroneous or, at least, too pessimistic.

The most important of these opinions were:

1. That it was impossible to obtain equally or even nearly as high efficiencies with wheels of high as with those of relatively low type characteristics, and
2. That attempts to increase the speed and power value any appreciable amount above those obtained with the best known American standard wheels (Smith, Samson, Victor and others) would necessarily result in pulling down the efficiency to values which would make the wheel uncommercial.
3. That it was impossible to obtain great overloads with high type characteristic wheels, or in other words, that if their load was increased even slightly above normal the efficiency would drop off rapidly and the wheel would be "overgated" very soon. It was thought that when a wheel of high type characteristic gave an overload of say 8 per cent it was quite satisfactory.
4. That with reduced load (part gate) the efficiency would fall off very rapidly and that the entire load-efficiency curve tended to be very unsatisfactory.
5. That the speed-efficiency curve was also unsatisfactory and that, therefore, high type characteristic wheels were not commercial under variable heads.
6. That in general the operating characteristics of these high-power wheels could not be controlled and regulated by the designers as well as those of low-power and low-speed types.

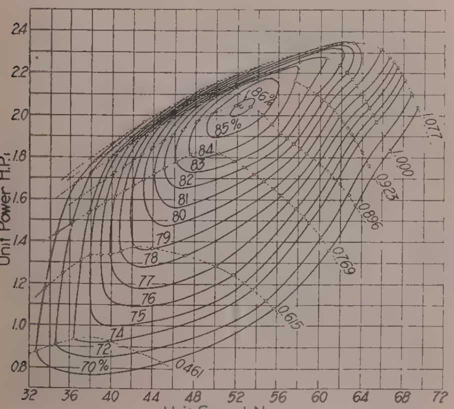


FIG. 1—HOLYOKE TEST RUNNER 1796

Diameter, 28 in.
Best efficiency, 86.2 per cent.
Normal speed, 52.2 r.p.m.
Normal power, 2.04 hp.
Normal K_t, 74.5 (specific speed).
Designer, C. W. Larner.

THE LARNER TESTS

The last complete account and discussion of a series of Holyoke tests was given by Chester W. Larner in his paper read before the American Society of Civil Engineers October, 1910. (See "Transactions," Vol. 66, page 306.) With one of the five wheels, all of which were of his own design, namely, with the wheel bearing the test number 1796, he set a new mark in the development of high speed, high-power wheels having exceeded the speed and power values of the best known American standard wheels, which held the record of having gone furthest of all in this direction and of having gone "about as far as one should attempt to go."

PART OF HOLYOKE TEST REPORT ON TURBINE 1796, MADE FEB. 25, 1909

1 Gate opening	2 Head, H, in ft.	3 Speed, N, in r.p.m.	4 Discharge, Q, in sec.-ft.	5 Brake horsepower	6 Efficiency, per cent	7 $N_1 = N/\sqrt{H}$	8 $Q_1 = Q/\sqrt{H}$	9 $Hp_1 = \frac{Hp}{H\sqrt{H}}$
1.077	17.11	153.00	97.00	125.20	66.52	37.00	23.45	1.76
1.077	16.99	199.67	101.16	147.66	75.84	48.50	24.55	2.10
1.077	16.94	224.33	102.98	156.38	79.04	54.60	25.00	2.25
1.077	16.89	239.33	104.50	159.58	79.72	58.20	25.40	2.30

It is proposed in this article to put on record some of the Holyoke tests made after test 1796 and to show what further progress has been made in the design of high-power wheels and to what extent the adverse opinions mentioned above have been proved erroneous or too pessimistic.

As space forbids giving the complete test reports of these wheels to be mentioned, their characteristics will be shown by curves drawn with greatest accuracy from the reported test values. For some wheels the "equal-efficiency curves" which show at a glance the behavior of the wheel under any conditions of speed and power will be given, whereas, for other wheels, to save space, only three curves will be given, one in each of the last three figures, showing the efficiencies at three different speeds plotted against power.

The "equal-efficiency curves" are equivalent to the contour lines of a topographical drawing representing a hill, showing instead of points of equal elevations points of equal efficiencies. As the efficiency is a function of two variables, speed and power, we may speak of an "efficiency hill" or an "efficiency surface."

METHOD OF DRAWING CURVES

The method of drawing these curves is very simple. From the principal data, copied from a Holyoke test report (see columns 1 to 6 of the table, which gives a part of the test report for wheel 1796) we compute the unit speed discharge and power values, that is, the speed, discharge and power, reduced to 1-ft. head (columns 7, 8 and 9). We then plot the power and efficiency values into curves using the speed as abscissæ and obtain thus for each gate opening at which the turbine was tested a speed-power and a speed-efficiency curve. From the speed-efficiency curves we find the speeds at which with the different gate openings the same efficiencies are obtained, and mark these speeds on the corresponding speed-power curves (which we draw in dotted lines on a new sheet). Then we draw a continuous curve through the obtained points. We do the same with the other efficiencies, drawing curves which must apparently resemble each other and change gradually one to the other. If any smoothing out is necessary, in order to correct errors of readings, this can now be done in the most rational way, but in order to avoid any criticism this smoothing out has been avoided, wherever possible, so that the curves given represent as accurately as possible the values reported by the flume. One of the advantages of these curves is that the real point of best efficiency can now be determined with almost absolute accuracy as the peak point of the hill. This point is marked by a double circle.

FIRST IMPROVEMENT

After the results of Mr. Larner's wheel 1796 became known the other turbine builders set to work to improve their turbines, making, however, no attempts to increase the power-speed values. The first company to report considerable improvement was James Leffel & Company, of Springfield, Ohio, which had obtained with an improved design of their Samson wheel an efficiency of 90 per cent. The curves of this wheel are given in Fig. 2. Remarkable is the broadness of these curves, indicating the great adaptability of the wheel to varying conditions of operation and particularly to varying loads. This fact is the more notable as the maximum efficiency also reached values which until very recently were thought impossible with wheels of high speed and power. At about the same time the S. Morgan Smith Company improved their Smith wheel (original test 1511), increasing its efficiency from 86.3 to 88.1 per cent. The three curves of this wheel are given in Figs. 8, 9 and 10.

In March, 1911, the test on the author's 12-in. wheel, which formed the basis for his later wheel designs, was made in Holyoke. The wheel was designed to prove the author's belief that by using correct proportions the speed and power values could be increased considerably and still a thoroughly commercial wheel obtained, without deviating from the generally adopted shape of runner.

The best efficiency was 83.7 per cent. It was obtained with a speed of 122 and a power of 0.46 (type characteristic 82.8). Reducing the power value to a wheel diameter which would give the same best speed as wheel 1796, namely, 52.5, we would obtain $(122/52.5)^2 \times 0.46 = 2.57$ as against 2.03, or an increase of 23 per cent. The efficiency of the wheel, considering its small size, was very satisfactory, for it is a fact, established by theory (see Professor Camerer's article in the "Zeitschrift des Vereins Deutscher Ingenieure" of Sept. 18, 1909) as well as by experiment, that the efficiency of turbines depends on their sizes.

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[*] The type characteristic, called by some engineers also the specific speed of a wheel, is the product of the speed in revolutions per minute and the square root of the power of the wheel, both under 1 ft. of head. It is expressed by the formula $K_t = N_1 \sqrt{HP_1}$.

According to the information obtained from H. F. Sickman, chief engineer of the Holyoke Water Power Company, the Holyoke tests show that a model wheel as small as the author's would always have from 2 to 3 per cent less efficiency than the usual sizes (say 30 to 36 in.) that are tested in the flume. This was in fact shown to be true when a 30-in. wheel of exactly the same design was tested (No. 2060). This wheel was built by the Allis-Chalmers Manufacturing Company from drawings submitted by the author and tested in September, 1911.

Fig. 3 shows the curves plotted from the test report. We see that an efficiency of 87.2 per cent was obtained with a speed of 49 and a power of 3.18 (type characteristic 87.4). The general characteristics of this wheel are in spite of its greater speed-power values and higher best efficiency no worse than those of test 1796; as a matter of fact this wheel is even somewhat more "flexible," thus furnishing a convincing proof that we were altogether too prejudiced in our opinions about further possibilities in the design of high-power wheels.

THE AUTHOR'S LATER WHEELS

Besides this wheel three other runners, designed by the author and built by the Allis-Chalmers Manufacturing Company, were tested. In designing these wheels the following specifications were to be followed:

1. To increase the speed of the original wheel simply by changing the curvature of the runner vanes only at the entrance and leaving the rest of the bucket vanes unaltered. Nothing specific was thus prescribed, and the design was made primarily for purposes of study. The author predicted that this modification would have the effect of increasing the unit power of the wheel if the wheel be overspeeded.

2. To modify the curvature of the runner vanes, without any changes in the general proportions and dimensions with the purpose in view of raising the best efficiency, the condition, however, being that the speed and power values must not fall below those which would give a type characteristic of 78 at best efficiency.

3. To design an entirely new runner with a new guide case with the purpose in view of raising the power and speed values so that a type characteristic of 90 would be obtained at best efficiency and the efficiency be as high as possible.

In all cases the same draft tube and general test arrangement was to be used.

The results obtained with these wheels are shown by the curves of Figs. 4, 5 and 6 (tests 2068, 2121 and 2122). The curves of Fig. 4 indicate that what the author anticipated with his wheel 2 came true. When overspeeded the wheel has a considerably higher unit power than under normal speed. This makes the wheel exceptionally well suited to variable heads, and especially when the low head is very much below the normal, for at low heads the wheel

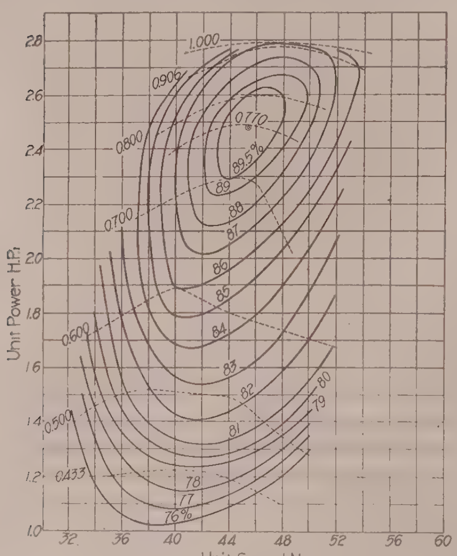


Fig. 2

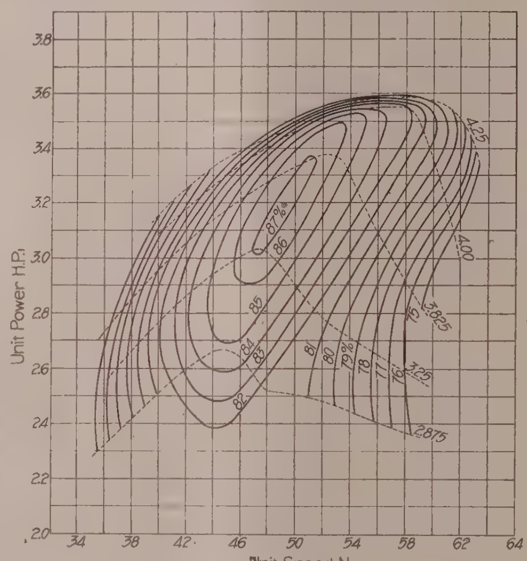


Fig. 3

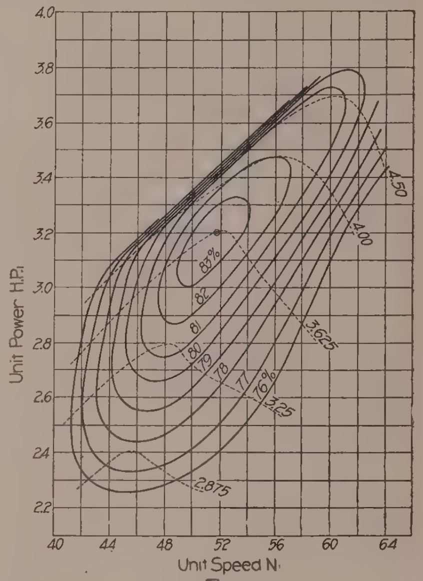


Fig. 4

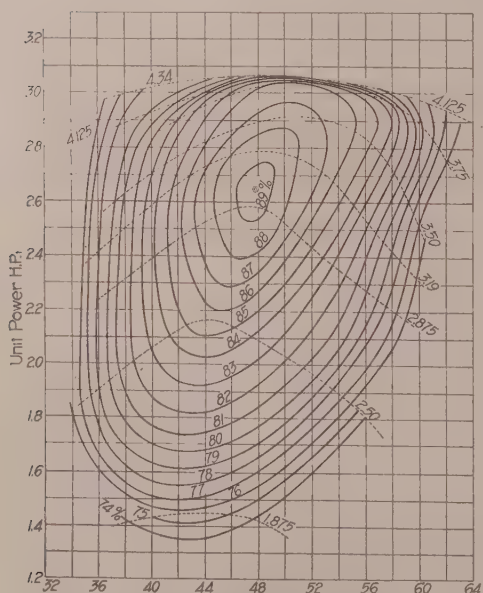


Fig. 5

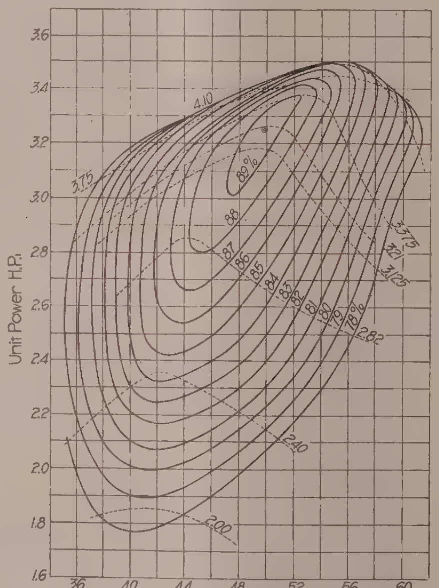


Fig. 6

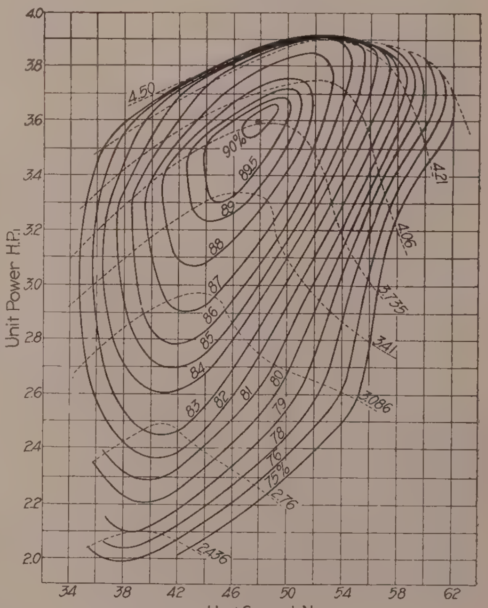


Fig. 7

FIGS. 2-7—CHARACTERISTIC CURVES PLOTTED FROM TEST REPORTS OF THE HOLYOKE TESTING FLUME

	Fig. 2	Fig. 3	Fig. 4	Fig. 5	Fig. 6	Fig. 7
Test, number	1889	2060	2068	2121	2122	2208
Diameter, inches	35	30	30	30	30	30
Best efficiency, per cent	90	87.2	83.2	89.2	89.3	90.1
Normal speed, r.p.m.	45.3	49.0	51.8	48.0	49.9	47.8
Normal power, hp	2.48	3.19	3.20	2.65	3.25	3.60
Normal K_s (specific speed)	71.3	87.4	92.8	78.0	90.0	91.0
Designer	Samson	Zowski, I	Zowski, II	Zowski, III	Zowski, IV	Zowski, V

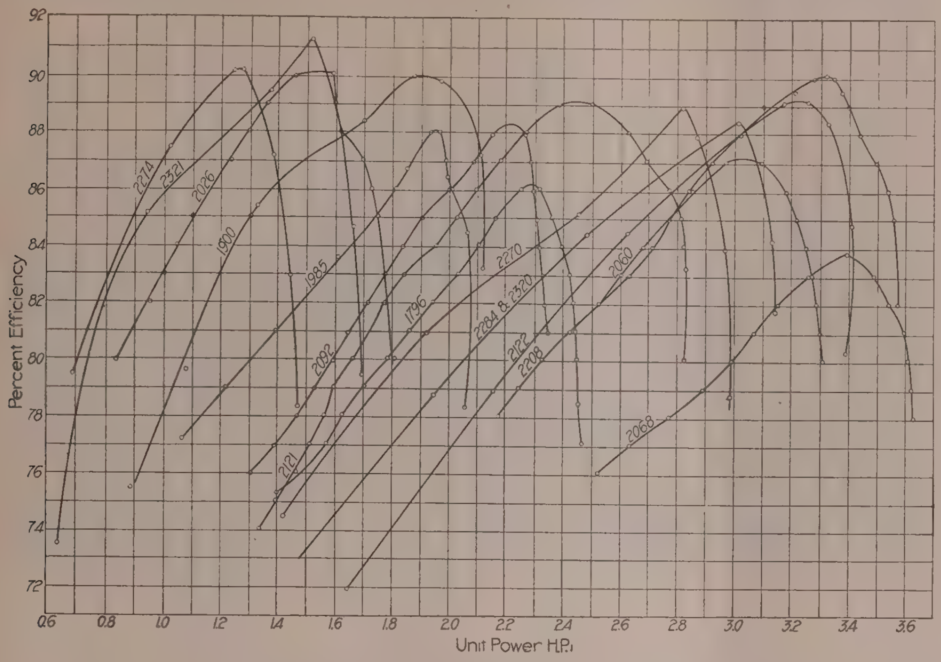


FIG. 8—POWER EFFICIENCY CURVES OF WHEELS HAVING A NORMAL SPEED OF 50 R.P.M. UNDER A HEAD OF 1 FT.—NORMAL SPEED CURVES

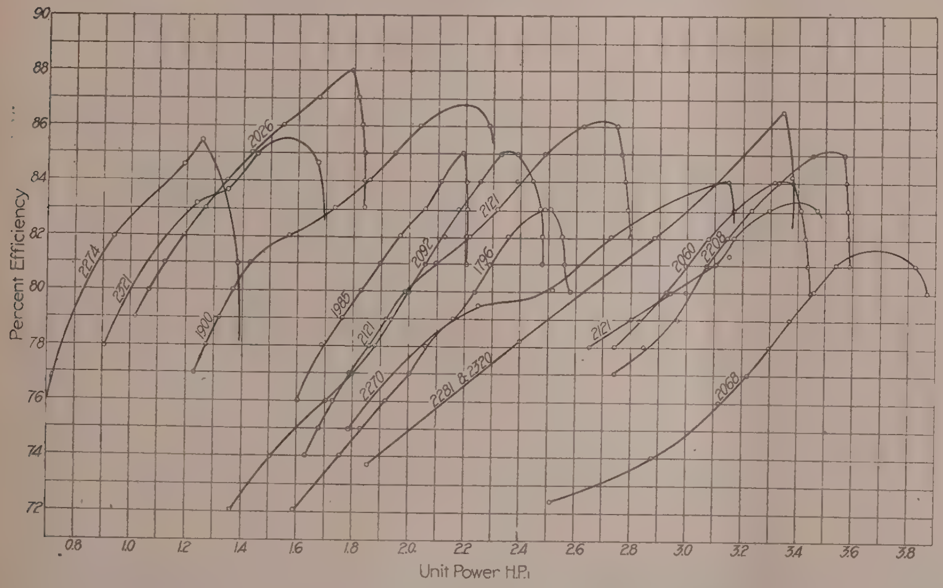


FIG. 9—POWER EFFICIENCY CURVES OF WHEELS HAVING A NORMAL SPEED OF 50 R.P.M. UNDER A HEAD OF 1 FT.—CURVES FOR 15-PER CENT OVERSPEED

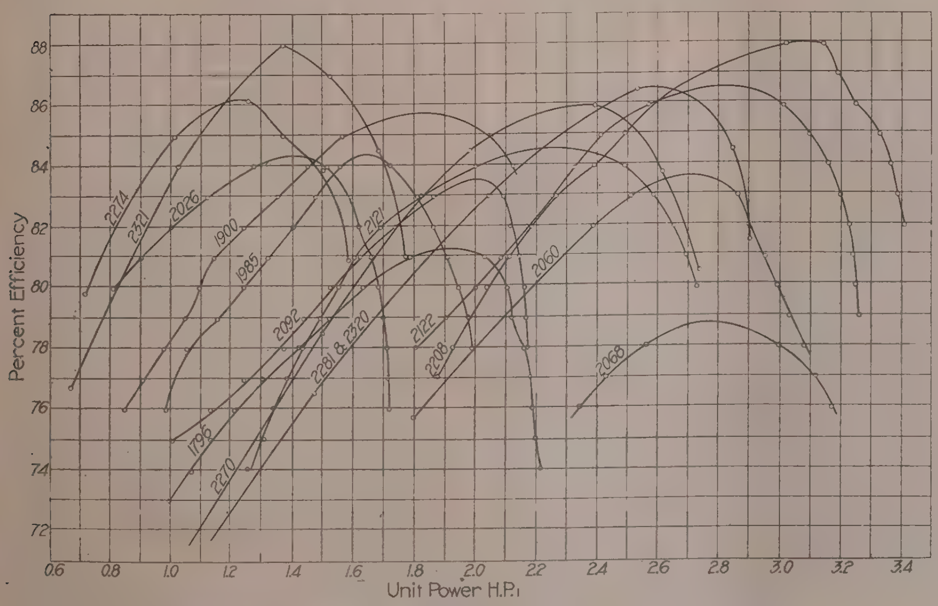


FIG. 10—POWER EFFICIENCY CURVES FOR WHEELS HAVING A NORMAL SPEED OF 50 R.P.M. UNDER A HEAD OF 1 FT.—CURVES FOR 15-PER CENT UNDERSPEED

must be overspeeded, and if the unit power is then increased this will counteract the reduction of the actual power caused by the decreased head.

Of course, this feature was not obtained without a sacrifice. The best efficiency was reduced, and whether this sacrifice would be too large as compared with the gain to give this turbine a preference over others is a new question, which can be answered only after a thorough investigation of all conditions of the given case. Test 2068 shows, however, the great possibilities of adapting high-capacity wheels to given conditions by using corresponding designs. The author is convinced that it is possible to improve the best efficiency of this wheel by proper design of the runner vanes, without spoiling its particular characteristics just described.

The curves obtained with the second modification (wheel 3, test 2121) given in Fig. 5, show a remarkable broadness, a feature found as a rule only in wheels of low type characteristics. The curves of Fig. 6 belong to the author's wheel 4, a wheel having other proportions than the first three. The best efficiency of this wheel reached the value of 89.3 per cent with a type characteristic of 90. The general characteristics of this wheel are about the same as those of the wheel 1, test 2060. The overload capacity is no worse than that which was usually expected from high-capacity wheels. The part-load efficiency is not bad, although it seems certain that the higher the speed and power value of a turbine the smaller the part-gate efficiency.

OTHER IMPROVEMENTS

In the meantime other engineers were developing new wheels or improving old designs. Two of these wheels interest us here, namely, the I. P. Morris wheel type E, designed by L. F. Moody (test 2026), and the improved wheel of Larner, test 2092. The I. P. Morris wheel is of relatively low-speed and power combination, but remarkable for its high efficiency at normal and part-gate power. Larner's improved wheel gave a higher efficiency than the original wheel 1796, maintaining about the same general characteristics.

The last wheel to be mentioned is the author's wheel 5, designed for and built by the S. Morgan Smith Company. The test of this wheel was made in February, 1913 (test 2208), and the result is shown in Fig. 7. The speed-power value is higher than in wheel 4, as is the efficiency, which reached 90.1 per cent (type characteristic 91). This wheel was also tested without a draft tube and gave 86.8 per cent efficiency. It was also tested with sixteen and twelve guide vanes (the original wheel had twenty guide vanes), giving 89.9 and 89.5 per cent respectively, and in every case the same general characteristics appeared in the almost identical shape of all curves.

All the above tests show clearly that it is possible to design wheels for very high speed-power values with good efficiencies and quite satisfactory efficiency curves; that the overload and part-load conditions are not so very bad, although it seems to be true that the higher the type characteristic of the wheel the more difficult it is to obtain very good efficiencies at part load, while it is probably impossible to secure as good values as we can easily obtain with wheels of the lower type characteristics. The tests, and particularly those of the author's wheels 1, 2 and 3, prove beyond any doubt that the operating characteristics of high-power wheels can be governed within a wide range of possibilities by simply changing the curvature and angles of the vanes and that it is therefore possible to design wheels of high power also to suit conditions and obtain certain desired results.

In order to give a clear idea of the progress made in the designing of wheels, the curves in Figs. 8, 9 and 10 have been prepared. These curves are based on and drawn from the curves as given above, but the power values are, to make the comparison clear, reduced to wheel diameters that would have exactly 50 r.p.m. for their best unit speeds. Fig. 8 shows the load efficiency curves of these wheels when running exactly at best speed, while Figs. 9 and 10 show the same curves when respectively overspeeded and underspeeded 15 per cent.

After this article was written four interesting additional tests of the Wellman-Seaver-Morgan Company were brought to the author's attention. These tests, which are further developments of wheel 1796 and 2092, will be found recorded in the curves of Figs. 8, 9 and 10—tests 2270, 2274, 2281, 2320 and 2321.

STANDARDIZATION OF CITY BUILDING codes in respect to the mechanical properties of timber of all kinds is one of the aims of the U. S. Forest Products Laboratory at Madison, Wis. In a paper delivered before the Western Society of Engineers, recently, Howard F. Weiss, director of the laboratory, stated that thus far more than 150,000 tests, of 100 species, have been made as to the effect of soil and climatic conditions on the strength of the timber. A survey of the building codes of the various states is being conducted. The greatest diversity in the allowable stresses was found in the different cities. One city, for example, will allow a working stress in yellow pine of 900 lb. per square inch, while another city, located less than 100 mi. away, will allow 1800 lb. for the identical species and grade. It is the aim of the laboratory to bring about a standardization of grade, quality and allowable stresses of timber.

MOTOR-TRUCK-AND-TRAILER TRAIN UNLOADING ROAD MATERIAL

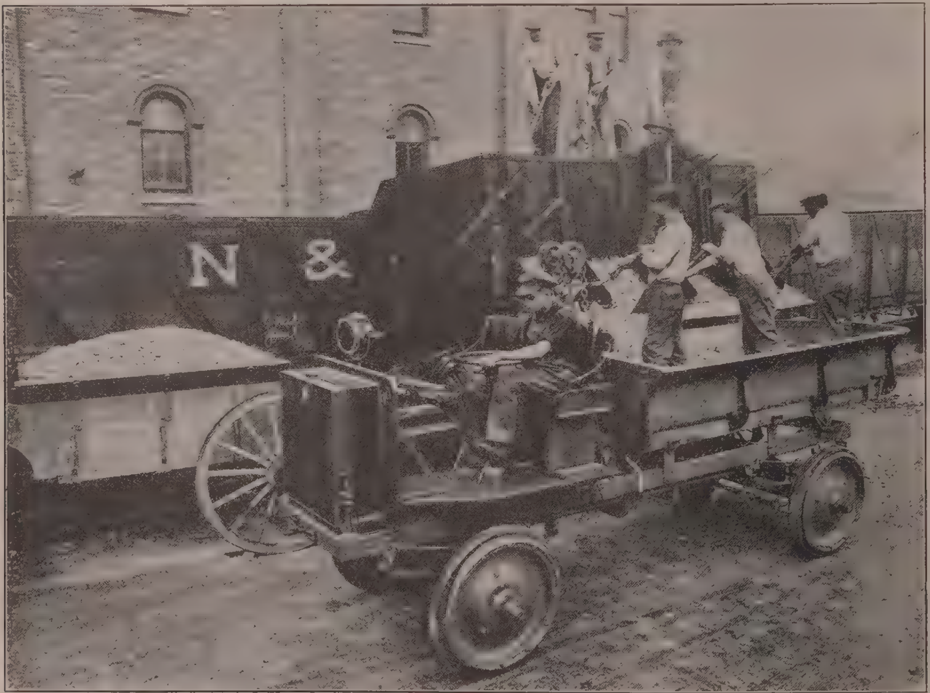
Motor Truck and Trailer Costs

Figures Derived from Tests to Show Saving over Teams and Wagons for 2.7-Mile Haul on Concrete Road Construction

A TEST was made recently at Kenosha, Wis., to determine the possible saving in the use of a four-wheel drive, brake and steer motor dump truck with trailers for hauling material 2.7 mi. from railroad cars in connection with the building of a concrete road. At the time of the test the work was being done by mules and wagons, at a cost of from $54 to $60 per day. With the motor outfit it is asserted that a saving of $35 per day was effected.

Using the mules or horses with 1½-yd. Bain patent dump wagons four trips per day were being made. The charge was $6 for team, wagon and driver. Hence the cost per cubic yard of material hauled was $1. The contractor usually employed nine or ten extra teams for this work. About 2000 cu. yd. of material to the mile had to be hauled. For the stretch over which the test was made half the distance was good concrete road, while about ½ mi. was loose sand.

After several test trips with the motor equipment it was found that the best results were obtained by using four trailers, leaving two at the team track to be loaded while the others were being hauled; hiring enough extra shovelers at the team track to keep the specially devised 8-yd. hopper full for the arrival of empty trailers; using one of the teams on the job to reverse the trailers while the truck was being turned around at the construction end, and letting the driver do nothing else but drive. Under these conditions it was found possible, with liberal allowances for delays, to make the time indicated in Table 1. At this rate



SPECIAL HOPPER TO MINIMIZE LOSS OF TIME AT LOADING POINT

TABLE 1—TIME REQUIRED FOR ROUND TRIP

Item	Time
Time to load truck	2 min. 0 sec.
Time to pick up loaded trailers	0 min. 45 sec.
Running time to job	22 min. 15 sec.
Time to dump truck and trailers, turn trailers around, reverse truck and couple up again	9 min. 45 sec.
Running time to team track, empty	15 min. 15 sec.
Total	50 min. 0 sec.

TABLE 2—TRUCK STATEMENT

Fixed Costs per Day	
Interest on investment of $3350 ($2750, cost of chassis, plus $600, cost of dump body) at 6 per cent, is $201 a year, which, reckoning 300 working days to the year, is, per day	$0.67
Garage rent, dead storage, $10 per month, which, reckoning 25 working days to the month, is, per day	0.40
Painting and annual overhaul (excluding running repairs) $150, which, reckoning 300 working days to the year, is, per day	0.50
Insurance and taxes, per year, $180, or per day	0.60
Driver's wages, per day	3.00
Total fixed cost per day	$5.17
Variable Costs per Mile	
Tires	1.78 cents
Depreciation of chassis (less tires), assuming life of 7½ yr. at 65 mi. per day	1.67 cents
Depreciation on dump body (value $600, life 5 yr.)	0.60 cent
Gasoline, average 5 mi. to the gallon (truck loaded and unloaded), at 15 cents per gallon (to allow for possible tax increases)	3.00 cents
Oils, waste and grease	0.40 cent
Repairs to truck	3.00 cents
Repairs to dump body	0.40 cent
Total variable cost per mile	10.85 cents

TABLE 3—TRAILER STATEMENT

Fixed Costs per Day

Interest on investment of $1,000 (four Bain 1½-yd. patent dumps at $250 each) at 6 per cent is $60 a year, which, reckoning 300 working days to the year, is, per day	$0.20
Yard charges for storage, four trailers, at $3 per month each, are $12, which, reckoning 25 working days per month, is, per day	0.48
Painting and annual overhaul (say $60 a year for four of them) amounts, per day, to	0.20
Total fixed costs per day	$0.88

Variable Costs per Mile

Depreciation on two trailers (two running while two are being loaded)	1.0 cent
Grease, etc., for two trailers	0.3 cent
Repairs and maintenance for two trailers	1.0 cent
Total variable costs per mile	2.3 cents

TABLE 4—SUMMARIZED COMBINED COSTS OF TRUCK AND TRAILERS

Fixed costs per day:	
Trucks	$5.17
Trailers	0.88
Total	$6.05
Variable costs per mile:	
Truck	10.85 cents
Trailers	2.30 cents
Total	13.15 cents

TABLE 5—COSTS PER DAY, PER YARD AND PER YARD-MILE, CORRESPONDING COSTS FOR TEAM OUTFITS, POSSIBLE SAVING WITH TRUCKS AND TIME NECESSARY TO RETIRE INVESTMENT

Trips per day	Miles per day	Fixed cost per day	Running costs at 13.15 cents per mile	Total cost per day	Yards hauled per day	Cost per yard hauled	Cost per yard-mile	Teams for same work	Cost of hiring teams	Gross saving of truck per day over teams	Horse-driver—hours in loading	Cost of extra loaders for truck and trailers	Net saving of truck per day over teams	Working days to retire investment out of profits
5	27.0	$6.05	$3.55	$9.60	22.5	$0.42	$0.15	3¾	$22.50	$12.90	7½	$2	10.90	398
6	32.4	6.05	4.26	10.31	27.0	0.38	0.14	4½	26.00	15.69	9	2	13.69	317
7	37.8	6.05	4.97	11.02	31.5	0.35	0.13	5¼	31.50	20.48	10½	2	18.48	235
8	43.2	6.05	5.68	11.73	36.0	0.32	0.12	6	36.00	24.27	12	4	20.27	215
9	48.6	6.05	6.39	12.44	40.5	0.30	0.11	6¾	40.50	28.06	13½	4	24.06	181
10	54.0	6.05	7.10	13.15	45.0	0.29	0.11	7½	45.00	31.85	15	4	27.85	156
11	59.4	6.05	7.81	13.86	49.5	0.28	0.10	8¼	49.50	35.64	16½	4	31.64	138
12	64.8	6.05	8.52	14.57	54.0	0.27	0.10	9	54.00	39.43	18	4	35.43	123

twelve round trips per 10-hr. day can be made.

Tables 2 and 3 give the detailed costs per day for truck and trailer, and Table 4 summarizes these costs. From these tables Table 5, which is self-explanatory, has been prepared.

The truck was a "Quad," furnished by the Thomas B. Jeffery Company, of Kenosha, Wis., which company conducted the test and gave the results in a copyrighted pamphlet from which the foregoing was abstracted. The contractor was George Wade.

TAINTER GATES WITHOUT CROSS BRACING, 33 ft. in length under a water pressure of 7½-ft. head, are employed in the spillway section of the Coon Rapids hydroelectric plant near Minneapolis, described in the Engineering Record of Jan. 17, page 77. According to J. W. Link in a paper recently presented before the Western Society of Engineers, they are built up of I-beams spanning the opening, framed into plate girders at the ends. From the girders struts extend to the pins. Between the beams and the struts gusset plates are inserted in lieu of the usual cross bracing. Gates of this type are held to be less liable to damage in case they are overtopped by a flood, due to the negligence of the attendant, or to accident which might prevent them being opened at the proper time. The hoists consist of two stands with chain drums, hand or motor driven by a worm gear from a line shaft. They are Whiting hoists and were specially designed by the manufacturers after specifications and suggestions by Mr. Link.

"Snow-Fighting" Force, Working During Storms, Will Clear New York's Streets

Commissioner John T. Fetherston, in Report to Mayor, Outlines Plans for New System of Snow Removal, Involving Use of Sewers

AS the result of the experience in removing snow from the streets of New York City last winter Commissioner John T. Fetherston, of the Department of Street Cleaning, has decided that the most effective way of attacking the problem is by a "snow-fighting" force—one that starts work as soon as a storm begins—and by the use of sewers instead of teams and trucks for carrying away the snow. Commissioner Fetherston explained some of the features of this plan in an article in the Engineering Record of March 28, page 352. Since that time he has worked out the details of the campaign to be inaugurated this winter and these are discussed in the following report, submitted to Mayor Mitchel on Nov. 10.

In past years the city depended upon trucks alone to haul snow from streets to waterfront dumps, the work starting as a rule after the storm was over. Traffic was retarded or completely blocked. No other method was considered available, and the speed of clearing snow from streets thus depended upon the supply of trucks for snow work. The maximum number of vehicles which could be procured last winter was 3000, and each truck averaged 50 cu. yd. per day. Under these conditions 150,000 cu. yd. of snow was the maximum amount per day that could be removed from roadways. With the 38-in. snowfall in February and March of this year it required over forty days to clear snow from the 1914 scheduled area of 20,000,000 sq. yd.

The only additional method of accelerating the removal of snow, up to last winter, was by decreasing the length of haul for trucks through the use of main trunk sewers for snow disposal, and only a limited number of such sewers was allowed in the Borough of Manhattan.

As a result of last winter's experience and tests it appears that the city has had available for years past a possible solution of the problem of rapid snow removal through the extensive use of sewers, not alone after a snowfall, but during the progress of the storm. A further principle has likewise resulted from the experience of this administration. Snow work should be started with the storm, *clean* snow dumped into sewers as it falls, and the attempt made to keep pace with the storm instead of trying to dig the city out after the block has occurred.

It should be recognized that these discoveries regarding snow work must be tested by a winter's experience, but whatever is done next winter in the disposal of snow through sewers must be considered as a decided addition to past methods, which likewise will be continued in operation.

Thus, next winter's plans contemplate snow work under three divisions, known respectively as the snow-fighting force, the snow-removal force, and the street railway force.

THE SNOW PROBLEM

The physical elements of the snow fighting problem, insofar as the area of streets scheduled for snow removal is concerned, are indicated in Tables 1 and 2.

An analysis of the monthly occurrence of maximum snow storms provides the data given in Table 3.

An analysis of snowstorms having a fall of 3 in. or over from 1905 to 1914, inclusive, is given in Table 4.

SNOW FIGHTING FORCE

Based upon the data concerning snowfalls it is planned to utilize all sewers having a sufficient flow of water to transport snow and, by means of regular sweepers acting as squad foremen, to assign emergency laborers in sufficient number to place in manholes snow falling at the rate of ½ in. per hour. The number of emergency

TABLE 1—TOTAL AREAS AND MILEAGE OF STREETS SCHEDULED FOR SNOW WORK

Borough	Street area, sq. yd.	Length, miles
Manhattan	13,120,225	373
The Bronx	3,028,421	86
Brooklyn	9,682,097	275
Totals	25,830,743	734

TABLE 2—DIVISIONS OF WORK

Borough	Street area, sq. yd.	Length, miles
Schedule for Snow Fighting Force		
Manhattan	10,045,252	285
The Bronx	2,021,185	57
Brooklyn	7,040,000	200
Totals	19,106,437	542
Contract Schedule, Mandatory Streets		
Manhattan	1,839,382	52
The Bronx	250,227	7
Brooklyn	1,214,400	35
Totals	3,304,009	94
Street Railway Schedule		
Manhattan	1,235,591	35
The Bronx	757,009	21
Brooklyn	1,427,697	41
Totals	3,420,297	97

TABLE 3—MAXIMUM SNOWFALL PER 24 HOURS IN THE PAST 25 YEARS

Month	Year	Snowfall in inches
November	1898	8.8
December	1890	14.
January	1910	13.1
February	1893	17.8
March	1888	16.5
April	1907	5.5

TABLE 4—STORMS EXCEEDING 3 INCHES, 1905-1914

	Maximum	Average
Number of storms per winter	7	4
Duration of single storm, hours	33	13.5
Rate of fall per hour per storm, inches	9/10	1/2
Depth of snow per winter, inches	42	21.3

men required for this purpose will approximate 15,000 per shift of 8 hr.

In addition to pushing snow into sewer manholes on scheduled streets where sewers are available for snow disposal, the snow-fighting force will remove snow from intersections of paved non-scheduled streets, placing it in sewers where such can be used, or otherwise piling it. It is also part of the plan to assign the snow-fighting force to clear the roadway at nearside street car stops.

Last year's experience in disposing of 800,000 cu. yd. of snow in large sewers demonstrated the economy of this method, the cost being approximately 15 cents per cubic yard. Special tests in the various boroughs, together with scientific observations conducted by the Sewer Bureau of the Borough of Manhattan, verified the general conclusion that all sewers having a sufficient flow of water can be utilized for the disposal of *clean* snow without injury to the sewers. On streets where sewers are unable to carry off the snow the roadway will be cleared and the snow piled for removal by carts or trucks.

For the purpose of showing the advantage of snow fighting work over contract removal a tentative estimate of the time required to clear the scheduled area in the three boroughs and the cost thereof is presented in Table 5. It is assumed that snow falls at the rate of ½ in. per hour, the storm continuing for 14 hours.

TABLE 5—ADVANTAGES OF SNOW-FIGHTING OVER CONTRACT REMOVAL

Item	Snow fighting force	Contract work
Estimated time required to complete work after storm ceases.	4 hours	168 hours
Estimated cost per million square yards cleared.........	$5,460	$22,438
Estimated total cost of clearing scheduled area	109,200	448,760

The estimate in Table 5, as well as all plans for snow fighting, is based on the following assumptions: That a sufficient force of emergency labor can be started at work, day or night, within 4 hr. after a continuing snowfall begins; that a rate of pay sufficient to attract labor and make the men anxious to work can be offered by the city; that the weather conditions will not be so extreme as will prevent men from working during the storm; that a sufficient amount of normal sewage is flowing in the bulk of the sewers to transport snow to the rivers and harbor; and that the ordinary flow of sewage can be supplemented by water from hydrants where the normal flow is insufficient to transport the snow.

As the snow-fighting method involves a new departure in snow removal, every effort has been made to plan the work so as to meet anticipated conditions. This has involved a tremendous amount of detail study and observation of factors heretofore unknown. To meet the various requirements of the snow fighting problem the following work has been completed.

SURVEY OF SEWERS

The depth of sewage and quantity of sediment in 50,000 sewer manholes and the velocity of sewage in 1098 mi. of sewers, in the Boroughs of Manhattan, the Bronx and Brooklyn, have been determined and the information plotted on maps, thus affording data not heretofore available concerning the ability of sewers to transport snow. The "campaign map," showing these data for the Boroughs of Manhattan, Brooklyn and the Bronx, is practically complete.

Weather Conditions.—Meteorological information regarding the duration, rate of fall, and depth of snowstorms has been studied and all published figures concerning snowfalls and their prediction by observation of the barometer, wet and dry bulb thermometer, direction and force of wind, cloud formation, etc., are available and will be used in conjunction with the weather reports from the U. S. Weather Bureau.

Labor Conditions.—A general examination has been made of the available supply of labor and plans for quickly filling the quota required on snow fighting have been prepared. It was planned to begin on Nov. 15 registration of snow fighters at the various section houses and stables. All printing and forms for this purpose have been ordered.

Assignments.—After the registration begins notification cards will be sent to all men on the list, giving their assignments and information as to time for reporting and location of stations. Each individual or gang will have a set task to accomplish within a specified time.

THE CALL TO WORK

Should a snowstorm start during the day the street cleaning force will be available, and emergency laborers with notification cards will have instructions to report without special notice. If, however, a storm starts during the night, it will be necessary to call all men. It is proposed that the police shall co-operate with the street cleaning department, so that when notice is given by the commissioner to police headquarters, all patrolmen will be reached by telephone as soon as possible and will call out the regular employees of the department, as well as the emergency men. A list of all employees and registered laborers will be furnished for each patrolman's beat in the three boroughs, and in this way it should be possible to get a large number of men into service on short notice. In addition to the notification by the police force, the night workers in each department stable will be utilized for calling men to work.

Equipment.—The principal tool used on snow fighting will be the sweeper's pan scraper, supplemented by road scrapers, scoops, plows, picks, etc., all standard department equipment. It is likewise proposed to increase the snow carrying capacity of sewers by using bags as temporary dams where necessary to increase the depth of water in the manholes.

Unscheduled Streets.—On streets where removal is not deemed essential, snow plows attached to automobiles and horse-drawn plows will be used for opening roadways for traffic. Street intersections with nearside car stops will be cleared while the storm is in progress.

WAGES FOR SNOW FIGHTERS

Regular Employees.—During ordinary work hours the time of regular street cleaning department employees on snow work will be charged against budgetary appropriations. Outside of regular work hours the time of employees will be charged directly against revenue bonds for snow removal. All overtime will be paid for at regular rates and, in addition, if the set tasks are accomplished within the time limits specified, all regular employees assigned to the accomplishment of such tasks will be allowed 50 per cent in addition to their regular rates of compensation. This excess during regular hours will be charged against revenue bonds for snow removal.

Emergency Men.—The cost of emergency labor will be directly chargeable against special revenue bonds and alternative rates of compensation will be allowed: First, 30 cents per hour for regular work; second, 40 cents per hour if the set tasks are accomplished within the time limits specified. This will enable the department to offer $2.40 or $3.20 per 8-hr. shift, depending upon the ability of the men to accomplish the work assigned, thus providing the needed incentive for men to work while a storm is in progress.

Assignments from Other Departments.—Extra clerks, inspectors, checkers, etc., for the snow-fighting force will be needed, and it is proposed to offer employees of all departments 50 per cent in addition to their regular rates for work in connection with the snow-fighting force.

The ability to pay men a bonus for the accomplishment of a set task and to provide a higher rate of compensation than can be obtained in ordinary work is one of the most important features of the snow-fighting plan. This is essential to the success of the method, as men will not work during snow storms unless extra pay is allowed.

Checking Work.—In each section or district floating checkers and inspectors of the finance department, in addition to regular foremen, assistant foremen and acting foremen, will verify the extent and quality of work performed to determine if the assignments have been completed within the time limits allowed.

Payments for Work.—Each snow fighter will be provided with a card in duplicate, to be punched at intervals by the foreman in charge of the gang and verified by the floating checkers, as well as by district inspectors acting under the direction of the Department of Finance. Payrolls will be based upon the punched cards, and each emergency laborer will be identified by a check in addition to the card.

ORDINANCES

Section 409 of the Code of Ordinances states: "In all cases the removal of snow and ice from sidewalks must precede the removal of snow and ice from the roadways." Should the city clear the roadway before the storm ceases, the property owners must co-operate with the snow-fighting force if they desire to have sidewalk snow removed from the roadways. This will afford an opportunity of securing the co-operation of property owners, tenants or occupants, who may thus become auxiliary members of the snow-fighting force. Should the owner, tenant or occupant fail to place sidewalk snow on the roadway before the latter is cleared by the city, it will then be necessary to pile the snow on the outer edge of the sidewalk, where it may be removed later or allowed to remain, depending upon the needs of the locality. The terms of the ordinance will thus assist the snow-fighting force and will tend to bring about that general public co-operation which is so much needed in handling emergency snow work.

A publicity campaign, giving the essential features of the snow-fighting work and the necessity for co-operation between citizens and the Department, will be started.

Three divisions will be organized for snow fighting. The first line of attack will comprise regular department employees, supplemented by emergency laborers. The unit of organization will be based upon the sweeper as leader of a squad of emergency laborers, working under the direction of regular department officers. The first reserve will consist of regular drivers with horses and carts, drafted for a night shift, to clear streets where the snow-fighting force cannot use the sewers. The second reserve will consist of private trucks for day or night service, used as a supplementary force when the two regular forces have been unable to cope with the storm. This reserve force will be covered by the registration of private vehicles and assigned as may be necessary according to the requirements of the situation.

Definite printed instructions have been drafted to cover all phases of the work, and classes have been started for the officers of the department. Drills of regular employees are being held, and night or day calls will be tried to prove their effectiveness.

The foregoing covers most of the factors involved in the problem of snow fighting, and practically all preliminary work in relation thereto has been completed.

SNOW REMOVAL FORCE

On Aug. 24, 1914, a report was made of the results of bids for snow removal work by contract, and the award of the contracts was approved by the Board of Estimate and Apportionment on Sept. 21. All preliminary work in connection with contract snow removal has been completed except the details of the assignment of men from other departments to the supervision of snow removal work. Approximately 700 loading and dump foremen will be required for this purpose, and it is expected that the various departments of the city will be able to provide the needed force.

It is proposed to pay all men assigned from other departments to the supervision of contract snow removal from the revenue bond fund, allowing 50 per cent extra pay while so employed. Tentative arrangements have been made with the contractors to place automobile and horse-drawn plows at work on the principal thoroughfares when a snowfall starts, with the object of keeping roadways open while the storm is in progress.

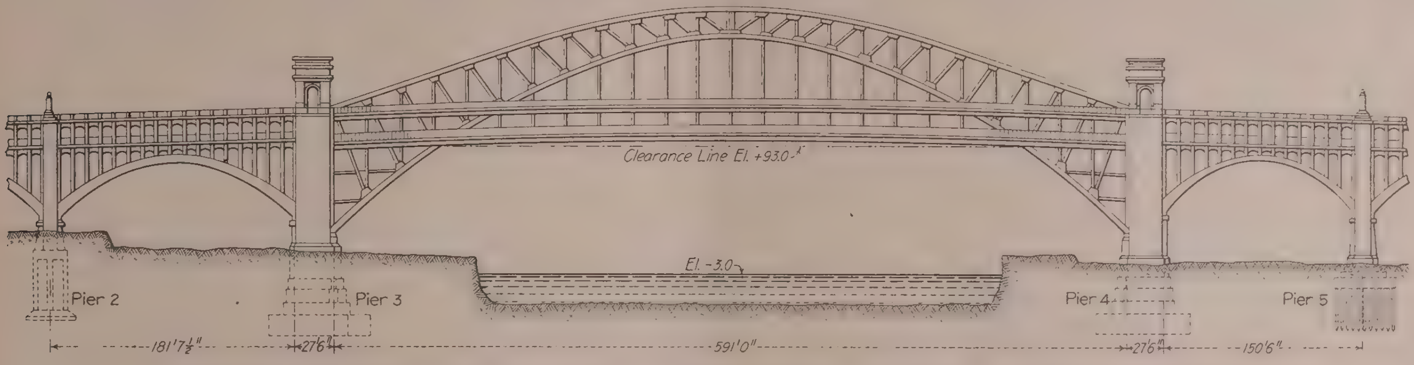
Assignments for the various street railway companies have been drafted and presented to the companies for approval. Negotiations for the use of sewers by the companies are under way, and will be reported upon by a special committee appointed by the Board of Estimate and Apportionment for this purpose.

Main Span of Detroit-Superior Bridge over Cuyahoga River at Cleveland

Riveted Through-Truss Three-Hinged Span of 591 Feet in High-Level Double-Deck Structure for Pedestrians, Vehicles and Electric Cars

THE main span of the Detroit-Superior bridge now under construction at Cleveland by Cuyahoga County is one of the most important examples of a spandrel-braced, three-hinged steel arch truss bridge yet built. Its most notable features are the general outlines of the trusses, the details of important members, the unusual truss and floor connections, the double-deck arrangement with four cantilever extensions providing for sidewalks, the wide driveways and six electric car lines, the heavy loads assumed and the various combinations provided for, and the combination of carbon and nickel steel and range of unit stresses adopted for them.

The bridge, which is 2880 ft. long, connects Superior and Detroit Avenues over the Cuyahoga River and valley and has a 591-ft. main river span flanked on both sides by steel and concrete segmental arch spans of from 75 to 181 ft. Both viaduct and main spans have throughout a lower deck for six car tracks and above this, about 16 ft. in the clear, an upper deck providing for a wide driveway and two sidewalks. In the main span the upper deck is located at about the level of the ends of the top chords, intersecting the lower chords at the fifth panel points from the ends. It carries a roadway 44 ft. 9 in. wide, paved with wood blocks, and two 15-ft. cantilever sidewalks of reinforced concrete. The lower deck, which is 80 ft. wide over all, is of open stringer construction, carrying two cantilever and four intermediate tracks on wooden crossties. Between the intersections of the upper deck and the lower chord of the main trusses the upper deck and lower deck floorbeams are single plate girders 76½ ft. and 80 ft. long respectively to the extremities of their cantilever brackets. They are rigidly knee-braced by solid-web brackets to vertical posts in the planes of the trusses, thus forming a portal construction suspended by vertical eyebars from the lower chords of the main trusses. At the ends of the spans the floorbeams are rigidly connected to the main truss verticals.



ELEVATION OF APPROACH AND MAIN SPAN OF DETROIT-SUPERIOR DOUBLE-DECK BRIDGE AT CLEVELAND

PANELING

The curved top and bottom chords of the main trusses are 49 ft. 3 in. apart on centers and have different radii, giving the trusses a depth varying from 20 ft. at the crown where the bottom chord has a rise of 144 ft., to 91 ft. 2½ in. at the ends. They are divided into twenty-four 24-ft. 7-in. panels with one vertical and one diagonal member for each. The chord sections are straight, changing direction at panel points, and vary in length from about 24 ft. 7 in. to 33 ft. 9 in. on centers. Except for the crown and skewback hinges all connections are riveted. The lengths of all truss members are corrected for changes in length due to the dead load. The pin at L12 lowers 5.3 in. due to dead load and 3.4 in. due to full live load. It has a variation in height of 7.4 in. due to change in temperature of 125 deg. The expansion joint at L0 provides for vertical as well as horizontal movement.

There are four systems of lateral bracing, namely, those in the planes of the top and bottom chords and those in the upper and lower decks, all of which have two-panel diagonal angle-braces, arranged to insure the delivery of wind stresses to the chords at their points of intersection with the decks and thence to transmit them to the main piers. The bottom chord is the principal arch member and is made up of two built channels 42½ in. deep with latticed flanges. The top chord, 27½ in. deep, is of similar construction, as are the vertical and diagonal members, except that in the case of the latter the flanges are turned inward. The chords are field-spliced at panel points, where pairs of very heavy gusset plates provide connections between them and the web members.

The lower-chord crown hinge joint is made with a 12-in. pin and the lower-chord skewback hinges are made with 16-in. pins engaging cast-steel pedestals with grillage bearings on the masonry. The estimated steel weight of the span is 3950 tons, about 1300 tons of which will be nickel steel. The massive concrete piers are built in steel sheet-pile cofferdams. The semi-arch trusses will be erected from them by the cantilever method, with anchor chains connected to reactions in the adjacent piers, supported on falsework, and adjustable by special toggle joints.

ASSUMED LOADINGS

The upper deck is designed for maximum live loads as follows: Roadway stringers, 24-ton truck with 12-ft. wheelbase, or 100 lb. per square foot; sidewalk stringers and brackets, 80 lb. per square foot; floorbeams and hangers, 24-ton truck occupying a space 12 ft. wide and 30 ft. long, and 80 lb. per square foot on remaining roadway.

The live-load impact percentage allowed is $100/(150 + L)$ where L is the sum of the loaded lengths of the lines of traffic in feet producing the maximum stress in numbers, assuming four lines for roadway and one line for each sidewalk.

For the lower deck the load on stringers, floorbeams, hangers and brackets is two 60-ton cars per track, with a load of 30,000 lb. per axle spaced 6 ft., 26 ft., 6 ft., 14 ft., 6 ft., 26 ft., 6 ft., and so on. The percentage of live-load impact allowance is $200/(270 + L)$ where L is the sum of loaded lengths of tracks producing maximum stresses in members.

The assumed wind loads are 50 lb., 25 lb. and 50 lb. per square foot of exposed surfaces of the windward and leeward trusses and floors respectively. When the stresses in the trusses and floorbeams are reversed on account of live load each is increased 50 per cent of the lesser stress. For combined dead, live and wind loads stresses are allowed 30 per cent higher than for dead and live loads only. Wind stresses less than 30 per cent of the dead-load and live-load stresses are neglected.

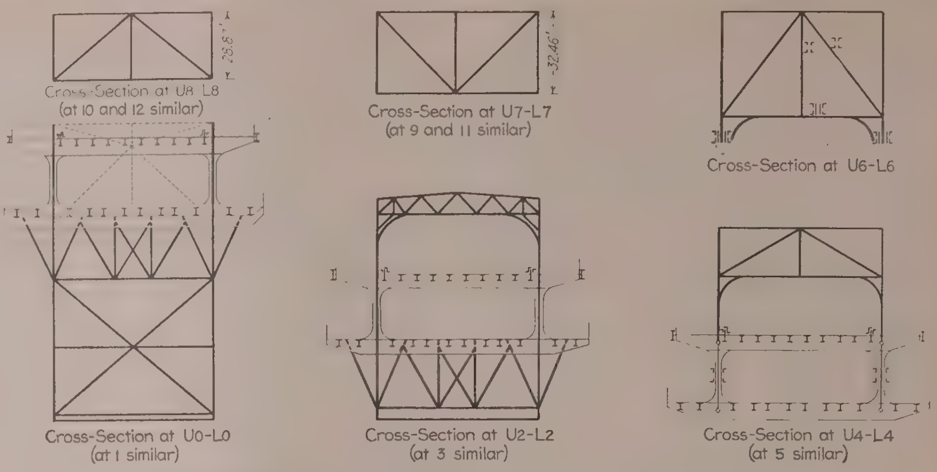
Truss load A consists of a uniform live load of 5000 lb. per linear foot for one truss. This load must be continuous and cover all that part of the structure which produces the same kind of stress in any member. Truss load B consist of a uniform live load of 10,000 lb. per linear foot for one truss. This load must be continuous and is assumed to have a length of six panels—about 150 ft.—or less. The percentage of maximum live load added to excess for impact is $100/(150 + L)$, where L equals the loaded length of span in feet producing a maximum stress in any member.

Combination load A consists of dead load plus live load A plus impact load A plus reversed load A. Combination load AW is combination load A increased by wind stress. Combination load BW is dead load plus live load B plus impact load C plus wind stress. This is considered a very remote but possible combination, therefore reversed stresses are omitted in its consideration. Combination E consists of dead loads of truss acting as a cantilever during erection plus the stress produced by the traveler and its load and neglecting wind stresses. Combination load EW is load E increased by wind stresses during erection..

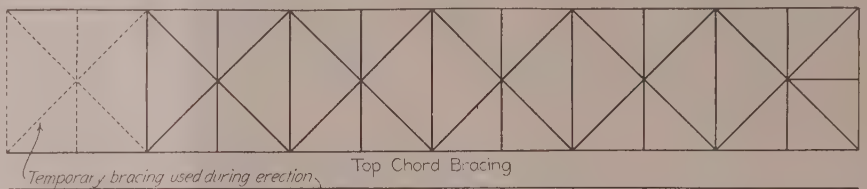
WIND STRESSES

Wind stresses are computed in accordance with the assumptions of application and distribution indicated by diagram, Cases I, II, III and IV. It was assumed that the wind shear was free to traverse any one of these four cases; the corresponding stresses have been computed for each and the maximum stress has been selected and marked on all members affected. The heavy lines in the diagrams indicate the planes at right angles to the trusses which contain wind bracing. The arrows indicate the direction in which the wind shear is assumed to be carried.

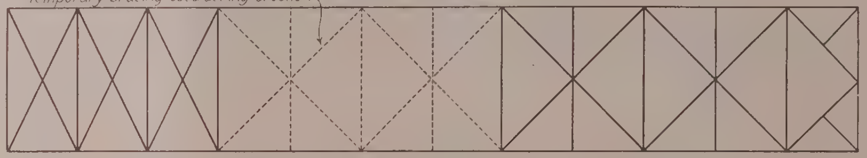
Eyebars, pins and truss members, except lacing and stay plates and the center top chord and vertical posts, are made of nickel steel. All other parts, except the steel castings, are made of carbon steel. For combination A loading the specified unit strength of the steel varies from 18,000 lb. shear in gusset plates and pins to 27,000 lb. tension in the hangar bars and 25,000 lb., reduced for compression, in the truss members. Higher unit stresses are allowed



CROSS-SECTIONS OF FLOOR SYSTEM AND BRACING IN MAIN SPAN

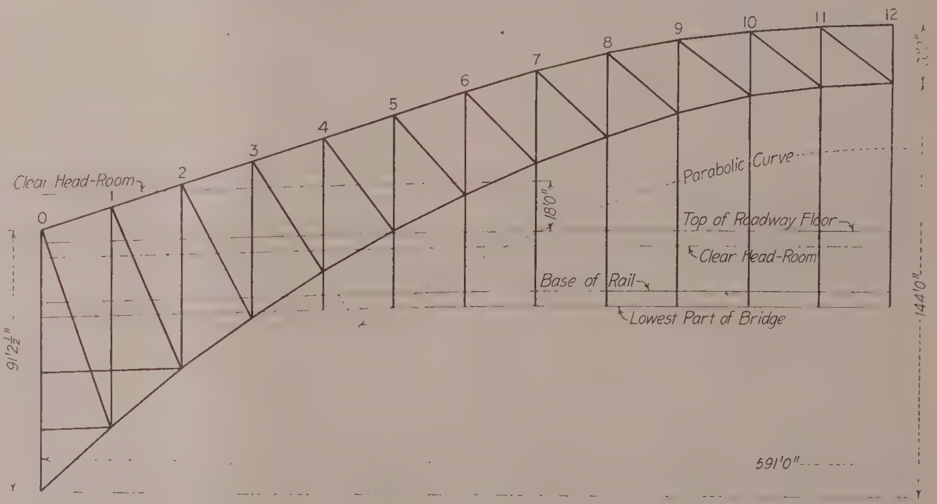


Top Chord Bracing

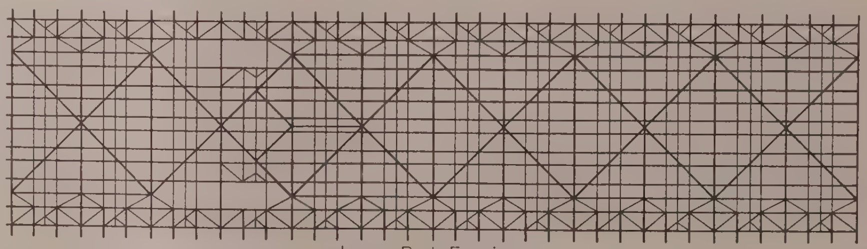


Bottom Chord Bracing

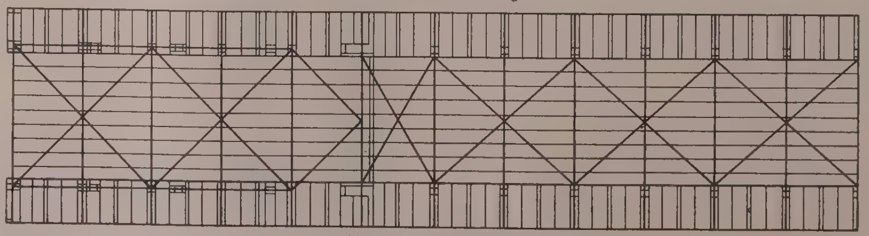
DIAGRAMS SHOWING CROSS BRACING IN TOP AND BOTTOM CHORDS



DIAGRAMMATIC HALF-ELEVATION SHOWING FRAMING OF MAIN TRUSS

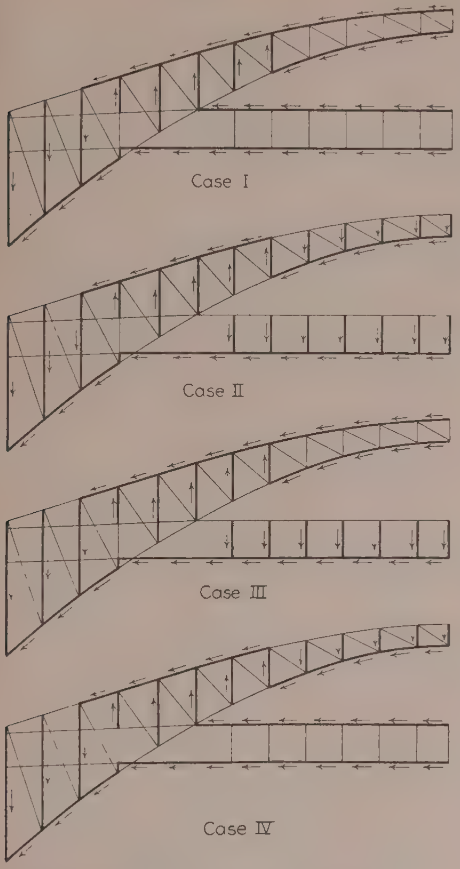


Lower Deck Framing



Upper Deck Framing

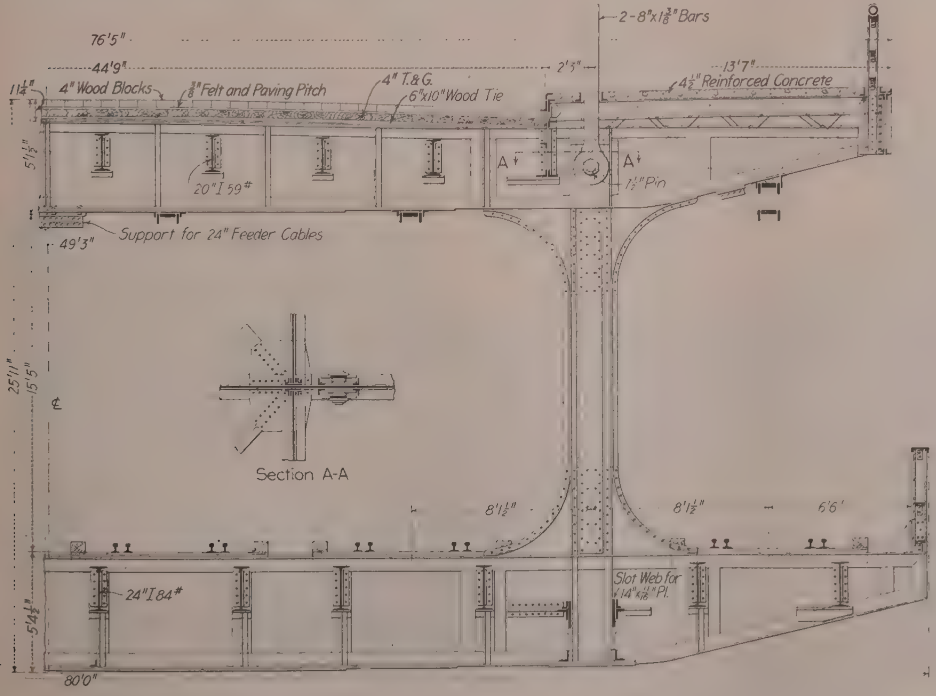
FRAMING DIAGRAMS FOR LOWER AND UPPER DECKS OF MAIN SPAN



DIFFERENT ASSUMPTIONS FOR CARRYING OF WIND SHEAR

for the other combinations. For the carbon steel a maximum unit stress of 18,000 lb. is allowed in beam flanges and bracing. It is required that all work shall have a preliminary inspection before riveting, that the weight must be marked on all members weighing more than 5 tons, and that all members shall be painted three coats of different colors of linseed-oil and oxide-of-iron paint.

The bridge was designed under the direction of F. R. Lander, county engineer, and A. M. Felgate, bridge engineer. Since then W. A. Stinchcomb and A. W. Zesiger have succeeded to the offices of county and bridge engineer respectively and are in charge of the construction, with J. A. Joyce, assistant engineer in charge of the steelwork. The contract for the main piers are awarded to the O'Rourke Engineering Construction Company, of New York City, for $276,200, and the contract for the steelwork was awarded to the King Bridge Company, of Cleveland, for $571,875.



CROSS-SECTION THROUGH DECKS, SHOWING DETAILING OF STRUCTURAL WORK

Additional Facts Regarding Collapse of Hippodrome Arcade

Building Inspector Charles C. Knox, of Youngstown, States that Design Was Not at Fault and Comments on Partial Removal of Second Floor Centering

AFTER the arcade of the Hippodrome theatre at Youngstown, Ohio, collapsed on Oct. 26, as noted in the Current News section of the Engineering Record of Nov. 7, a letter was sent by this journal to Charles C. Knox, inspector of buildings at Youngstown, asking him to make a statement regarding the accident. This he has done; his communication is printed below:

"I have received a number of inquiries from builders, architects and engineers in reference to the collapse of the theatre arcade in our city, and they note that they have seen an account of same in the Engineering Record. Also your letter of Nov. 11, written to the Trussed Concrete Steel Company, has been handed to me with the idea that I might have more to say than at my last writing. I regret that even at the present time I can give you no information regarding the actual cause of the collapse of the Hippodrome building. However, this matter is still undergoing investigation, and some progress has been made.

DESIGN NOT AT FAULT

"I can assure you that the design was not the cause of the failure. This has been executed in accordance with the best known practice, and was checked and approved by J. C. Spencer, consulting engineer, of Cleveland, Ohio, so that every possible precaution was taken, both by the architects and the Trussed Concrete Steel Company, to see that the design was all that it should be. Furthermore, the first floor live load, for which the design was made, was 150 lb. per square foot, whereas our Youngstown building code requires only 120 lb. per square foot for this class of building.

LOAD TESTS

"In the course of our investigation we are taking into consideration not only the materials and workmanship, but also the type of design. In order to definitely settle this latter point, it was determined to conduct a load test on the floors of the Youngstown Y. M. C. A. building, which is now being constructed of the same materials which were used in the Hippodrome. Our purpose was to make this test as severe as possible, and therefore we chose panels sufficiently isolated that they derived little strength from continuous reinforcement extending into them from adjacent panels. These panels were subjected to a load of 180 lb. per square foot, which was double the live load for which the floor was designed. The actual loaded area comprised 715 sq. ft. The beams were set 27 ft. 6 in. long, and the slabs 14 ft.

"After the load was applied to the full area, and during its application, accurate measurements of the deflections were taken by means of gages, and these were checked by several level readings taken from the top of the floor. The final deflection under the full load was shown to be the remarkably small amount of ⅛ in. for the beams, and ¼ in. for the slabs. This beam deflection is only 1/2200 of the span, or approximately one-fourth of that which is allowed by most conservative practice. The deflection of ¼ in. found in the slabs was the sum of the beam and slab deflection. Therefore, the actual slab deflection, between supports was only ⅛ in., this being approximately 1/1100 of the span, which would indicate that the actual stresses on both steel and concrete were much lower than those on which the design was figured.

"It is our intention to apply a similar test to the floors in the portion of the Hippodrome still standing, and we expect thereby to secure interesting comparisons with the Y. M. C. A. building. These comparisons will be all the more valuable since the steel stress in the two structures is exactly the same, while the working stresses in concrete are somewhat more conservative in the Hippodrome building.

REMOVAL OF CENTERING

"Regarding the account which you have given of the failure in your issue of Nov. 7, while the facts and dates are substantially correct, they are not entirely clear in connection with the second floor. The inference is that the second floor centering had not been touched, whereas the facts are that the second floor forms and centering for one of the panels that collapsed were partly removed, so that the contractor could proceed with placing of partition. Undoubtedly supports were put back, both under the beams and slabs, since the second floor concrete had only been poured approximately three weeks, and could not possibly have attained its final hardness. It is impossible, however, to determine exactly how many shores were used, since the accident occurred shortly after the stripping was completed, and all the shores which were used were mixed in the wreckage with the forms for the roof concrete.

"I have, however, been very much impressed during my investigation of this accident with the fact that there are very few building codes or specifications which are absolutely clear regarding the question of removal of centering, and I believe that your publication could do a great work toward the safety of the building construction by educating contractors, and even some engineers, on this subject. The usual specification would lead one to believe that for the safety of work, it is only necessary to be sure that the centering is allowed to remain undisturbed for a given number of days, and there seems to be a general impression among contractors and builders that, provided 28 days are allowed to elapse between the time of pouring concrete and the removal of the centering, there will be no possible danger of failure. This impression is not only erroneous, but in some cases positively dangerous, since it gives the contractor a false sense of security, which may prove fatal at times of the year when warm days are accompanied by cold nights.

CONCRETING IN COLD WEATHER

"My investigation has convinced me that under certain conditions, concrete will not attain its final hardness in 28 days. In fact, in certain instances six weeks has not been a sufficient period to permit final hardening. Such conditions, causing the retarding of hardening, seem to exist more often during the months of September, October and November. It seems to me, therefore, that if, during these months, you would give this subject great prominence in your publication, both editorially and by means of articles written by prominent engineers emphasizing this condition, you would be educating the contracting and engineering profession along a line which would tend to prevent concrete failures.

"It is my opinion that accidents would be rare if, in every instance, not only the contractor, but also the superintendent and engineer inspecting the job, were fully alive to the fact that it is of prime importance, not only to allow the centering to remain for a fixed number of days, but also to be absolutely sure that the concrete has received its final hardness before the centering is removed. The ordinary means of determining this are so simple that they could almost be applied with intelligence by a boy. Yet I am convinced that there are many interested in concrete construction, who have not a full appreciation of the importance of making these tests. There are possible cases where these precautions would not prevent ultimate failure, but they would eliminate those failures which result from a poor quality of concrete or from the premature removal of forms."

Augmenting Water Supply of Springfield

Underground Reservoir Is Formed by a Thin Cut-Off Wall and 10 Miles of Mains Are Added to Distribution Mains in Belt Line for Ohio City

HAVING completed work on increasing the supply end of the waterworks, Springfield, Ohio, is now engaged in laying 10 mi. of belt-line mains, 10 to 16 in. in size, around the outskirts of the older part of town. The new line is designed to feed the newer growing sections and to restore the pressure in the downtown districts.

Water for the 60,000 people of Springfield is obtained from a large open well, 30 ft. in diameter and 22 ft. deep, located 4 mi. from the center of business on Buck Creek. Three-quarters of a mile above the station a low concrete dam was constructed allowing a portion of the flow to be diverted to irrigate 3 acres of the 100 acres of gravel river bed owned by the city. At the pumping station, completed in 1898, the creek valley is 1200 ft. wide with the low water channel near the rather abrupt eastern bank. Impervious clay with a fairly level cross-section underlies the 22-ft. gravel layer, having voids of 25 per cent.

SUB-SURFACE DAM

As the clay follows up the banks George S. Cotter, superintendent, conceived the idea that a concrete curtain wall or underground dam thrown across the valley below the pumping station would create an underground reservoir into which water could be diverted from the creek at the dam ¾ mi. upstream and obtain the benefit of horizontal filtration through this length of gravel.

Three years ago the dam was built. It was founded 1 ft. below the top of the clay. The base slab is 2 ft. wide and 1 ft. deep. On it was erected a simple curtain wall 12 in. thick rising to the surface and depending entirely on the fill behind it for stability. There is a 2 to 3-ft. layer of loam over the gravel layer which affords protection from any rapid local infiltration of water near the well and its open joint tile pipe feeders.

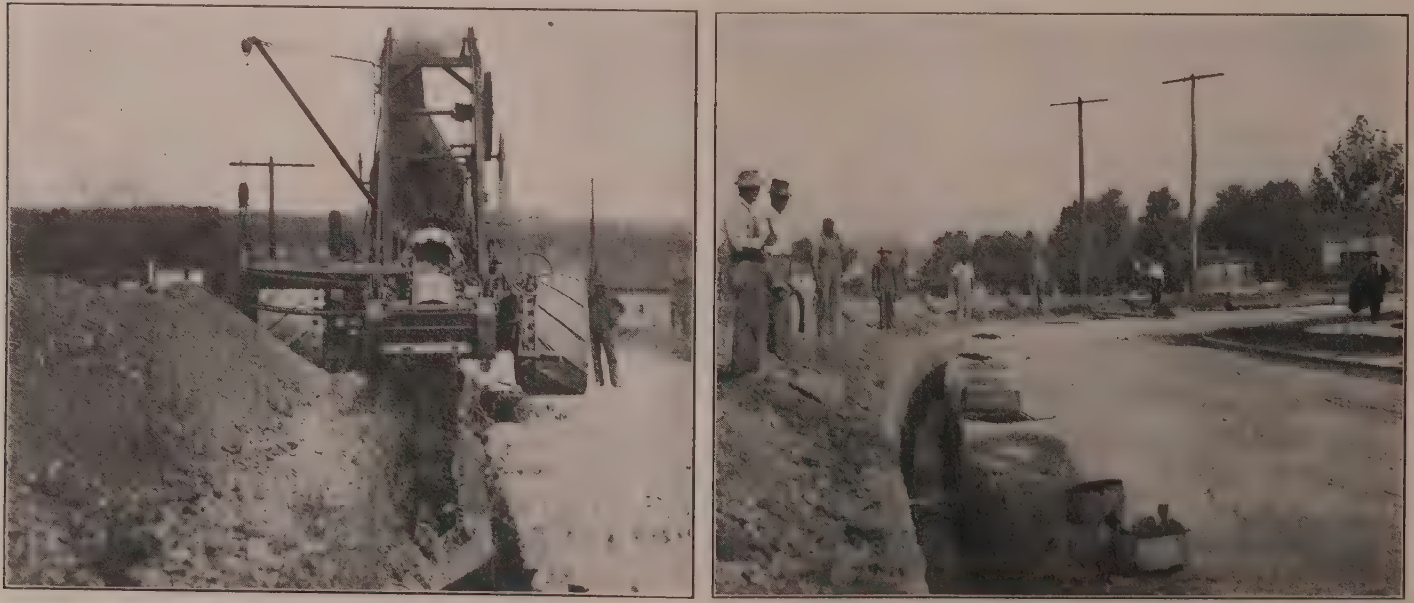
CLOTHES WASHERS INCREASE PEAK LOAD

As to capacity Mr. Cotter estimates that 20,000,000 gal. can be withdrawn safely from the well. Already, with the addition of the new 12,500,000-gal. Allis-Chalmers triple expansion pump put in service in May, a 15,000,000-gal. daily rate has had to be maintained for several hours on Monday morning when 4000 hydraulically operated clothes washers are in operation. Springfield makes no charge for these machines and in consequence their number is rapidly increasing. With a pressure of 70 lb. a machine uses 250-gal. per hour.

Buck Creek has a watershed of 4000 sq. mi. and is fed in dry weather largely by springs. Lowest weir measurements indicate 30,000,000 gal. daily available. There are towns on its banks but it courses through a rich agricultural district.

BELT LINE CONSTRUCTION

In 1913, 8400 ft. of 20-in. main were laid from the pumping station down the north side of Buck Creek and connected with a 20-in. main at the abandoned waterworks below the mill race headgates. A 20 and 24-in. main already existed. Contracts were let for 10 mi. of mains to encircle the older part of town. Connections are made to all smaller lines crossed, the city having no high pressure district. After the pipe was on the ground the contractor became bankrupt and the American Cast Iron Pipe Company, to get its money out of the



TRENCHING MACHINE AT WORK AND CURVED TRENCH FOR CAST-IRON PIPE IN SPRINGFIELD, OHIO pipe, is putting it in the ground. With few exceptions the material is clay and stands without bracing. Practically all of the trenching was done with a Buckeye traction ditcher. Pipe is laid with a 4-ft. cover over the shell and trenches 27 in. wide are excavated for 16-in. pipes.

Bell holes, a "pick handle length" long, 36 in., are cut 6 in. deep at the joints from a point about 10 in. behind the bell. Pipes are handled by two men and a carrier made from the two front wheels of a wagon with the tongue made solid to the axle. A chain thrown around the latter and the pipe, with the tongue raised, gives a chance to lift the pipe easily by the long leverage of the tongue. About 3 in. of loose earth is left in the bottom of the trench and the pipes dropped onto this cushion. No breakages occur unless a pipe hits another or stones are left in the trench. Bringing the spigot home into the bell end of the pipe already laid is accomplished by raising the spigot end with a Peerless triplex block suspended from an eye-bolt in the center of a 4 x 4-in. oak timber thrown across the trench about a foot ahead of the joint. One man with a stick in the bell end pushes the pipe home.

TESTS

Tests for tightness are made before backfilling sections of 500 to 1000 ft. long, under 75 lb. pressure, the engineer going over the line with a 3-lb. testing hammer. If leaks at joints occur, the lead is recalked at once. Where valves are not available a wooden plug is used. Water in the pipes is let into the ditch where the pipe is laid. After the removal of the plug and after reaching its level it is dammed off just back of the open end and then pumped out.

Backfilling is done entirely by a scraper with two men and a team. After filling to one-half the depth the trench is thoroughly flushed and left to settle until the succeeding day when another flushing is given before filling in the remainder of the earth. Earth is heaped up over the cut about 12 in. and sloped off for 2 ft. to each side to make passage of vehicles easy and to bridge the trench for the heavier trucks.

About 2100 ft. of water-bearing sand under the clay has been encountered that required trench bracing. Dams were made on each side of the joints after the pipes were pulled home and water pumped out with a 3-in. Goulds' hand pump. Progress here was but 300 ft. per day.

At a mill race crossing three lengths of pipe were leaded up above water, dropped into place and the ends dammed off to make connections.

The trencher is the prime factor controlling the progress. Ordinarily 700 to 800 ft. per ten-hour day can be laid complete. On one of the best days, July 9, 1100 ft. of trench were opened and 1350 ft. of pipe laid. This progress was accomplished with a force of 35 men distributed as follows: 2 yarning, 1 pouring lead, 3 calking, 1 tending lead pot, 2 backfilling with 2 teams, 6 cleaning trench, 4 pulling pipe home, 4 placing pipe on edge of trench, 8 digging bell holes and 3 operating trencher. Ordinarily the force is about 30 men, fewer men being used in cleaning trench and digging bell holes, also one less team backfilling. In built-up districts, 50 per cent of the time of the trencher is lost on account of raising for services. Usually there are two to each 50-ft. lot. Two men spend an hour at each service digging the trench left by the machine.

George S. Cotter, superintendent of waterworks, planned the extension and is supervising their installation. All work is under the general supervision of Charles E. Ashburner, city manager. C. E. Abbott represents the American Cast Iron Pipe Company, and Walter H. Weaver is the city's resident engineer.

Engineers From the Contractors' Viewpoint

The "Boy" Engineer and His Influence—Danger Signals for Contractors—The "Specification Fiend"—Preliminary and Final Estimates

BASING his views upon an experience in the construction of public works—both as an engineer and a contractor—dating back to 1866, Richard W. Sherman, chief engineer of the State Conservation Commission of New York, discussed the engineer from the contractor's viewpoint in a paper presented Oct. 27 to the Albany Society of Civil Engineers. An abstract follows:

I have known experienced contractors who when they read a list of engineering graduates said, with an air of despair, "See what has been turned loose on us now." Contractors dread the "boy engineer" just from college without any practical experence in construction. Experience as contractors has taught them that the engineers just graduated, with a few exceptions, are prejudiced against contractors. These young engineers are extremely technical. They expect a literal compliance with every iota of the contract obligations by the contractor, concede the contractor few if any rights, consider the engineer as infallible and final in all matters under the contracts and almost scoff at the contractor's views of his rights and his construction of the meaning of contracts and specifications. These young engineers, however, improve with time.

DANGER SIGNALS FOR CONTRACTORS

I knew an experienced contractor who, when he first met the engineer in charge of a piece of work on which bids had been invited, would offer him a cigar. If he refused it, the contractor would ask him to take a drink. If he declined and in the course of his conversation did not use as much as one little cuss word, the contractor would go home without bidding. He did not want any work under that fellow. He said such an engineer had neither soul nor heart and was not fit for God or man. As severe as my friend's condemnation was, it is in a way indicative of the disposition of the engineer and that he would be a hard man under whom to do work.

As to smoking, it has a sociable and amiable feature. If a man can afford it and it is not detrimental to his health and he enjoys it, why seemingly he should smoke. While a man may be sociable by taking a "soft" drink, he may also be sociable in alcohol. There is no objection from any standpoint whatever to an engineer being a teetotaler as to alcohol. Many an engineer has ruined his life by inebriacy. Contractors are rather fairly disposed towards the engineer who doesn't go beyond "soft" drinks.

As to profanity, there is nothing to be said in its favor, but if an engineer is so stoical that he is never stirred to profanity, he is as a rule a cold-blooded proposition and some contractors will avoid doing work under him.

Contractors are largely influenced by their opinions of engineers. The engineer who has a reputation for ability, honesty, fairness and good disposition will attract bidders and the desire to do work under him would be an incentive to reasonably low prices. On the contrary, if contractors consider an engineer incompetent, dishonest, an inebriate and of a cranky disposition, they will often avoid bidding or add to their bids a sum which they hope will cover the excess cost of the work due to the general "cussedness" in the make-up of the engineer. It is a feature of contracting to size up the engineer with as much accuracy as possible, and many contractors become very expert thereat.

In bidding for work, contractors are almost as sensitive as weather vanes. As a rule, they run quite a risk of loss if they bid too low; and the engineer is at least one of the most important features in the situation. By reason of the characteristics of the engineer it may be possible to make a profit at a given bid under one engineer and impossible to avoid a loss under some other engineer with all conditions aside from the engineer himself precisely similar and the quality and the merits of the work constructed equally good at the same cost to the owner in each case. The treatment which bidders think they will receive from the engineer if they secure the work is an important feature of the bidding.

ESTIMATES OF WORK

An engineer who can make reliable preliminary estimates will find his services in demand by municipalities, corporations and other owners, or if he chooses to practise as a contractor's engineer he will find his services of great value in that field. Some prominent successful engineers of my acquaintance would not under any circumstances do engineering work for contractors, confining their services entirely to the owners. I know of other engineers who confine themselves wholly to engineering for contractors and who do a large business as engineering experts for contractors in litigations. These two fields of engineering are becoming more and more distinct and an engineer is wise who makes his choice and adheres strictly either to the one line of practice or to the other.

In the matter of monthly and final estimates, contractors, particularly those ignorant of engineering, are very prone to suspect that engineers have underestimated or cheated them. There never has been any good reason why contractors should not check up measurements and quantities even if it is necessary to employ contractors' engineers to do so. In large contracts this has been the custom for some years and is becoming more so. Great injustice has been done engineers, as many intelligent contractors know, by the perpetual suspicion that the engineer is under. There is seldom a motive other than spite for an engineer to cheat a contractor and the spite cases, I believe, are very rare. In small works, such as village waterworks and sewers, some engineers may be tempted to underestimate in order to keep the cost of the work down to the preliminary estimate or appropriations. I trust there are not many such, but I fear there are some.

An indolent, lazy indifferent engineer and also a procrastinator are torments to contractors and a cause of considerable unnecessary cost in executing the work. Detailed plans, specifications, etc., should be promptly furnished. Work should be promptly staked out. Decisions in all matters pertaining to the contract and specification with which the engineer has authority should be promptly made.

Incomplete Specifications

In the matter of drawing contracts, specifications and papers pertaining to lettings on very large and important works, such documents usually are models of as close an approach to perfection as can be reached. I have in mind in particular those of the Metropolitan Water and Sewerage Board of Massachusetts, and doubtless there may be others as meritorious. Such perfect documents are a great credit in particular to the principal engineer and perhaps in a considerable degree to his assistants and in some degree possibly to lawyers.

In smaller works, such as may amount to not more than $200,000, contractors are often confronted with bidding papers, contracts, specifications, plans, etc., which are a disgrace to the engineer who drew them and yet that very engineer may be very proud of them. His pride would not last long if he were to hear contractors' comments on his productions.

"Specification Fiends"

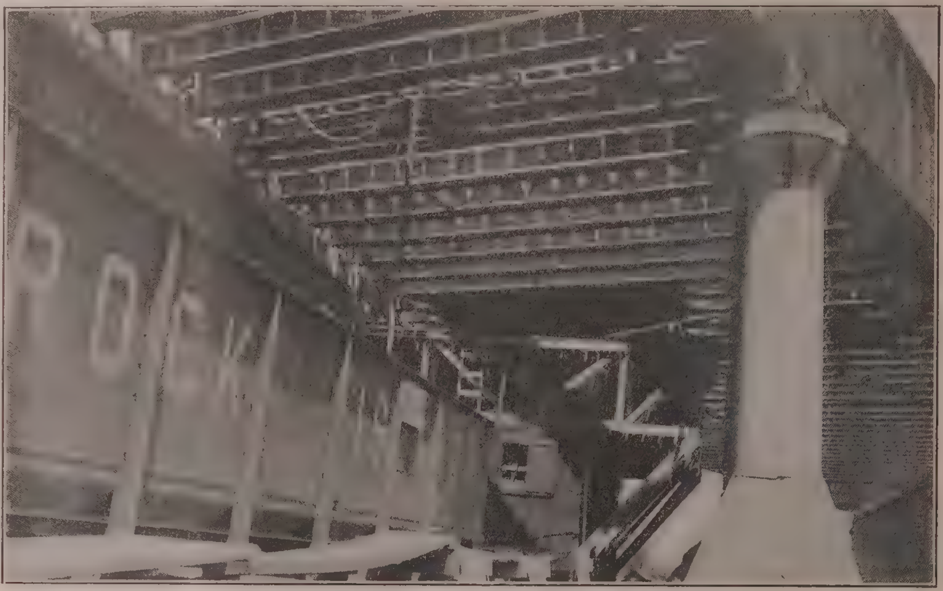
There are a few engineers who are sometimes called "specification fiends." They write to many places where work is advertised for specifications, etc. They read them eagerly and often clip such paragraphs as catch their fancy, and usually those which are harsh, severe and unreasonable from a contractor's standpoint. With these clippings to aid them they draw up "crazy quilt" specifications. They often include in notices to contractors matter which belongs only in the specifications and sometimes put in the contract or specifications matter which belongs only in notices to contractors. They have no idea of arrangement of subjects or proper place and order. Such papers are full of contradictions, useless paragraphs and ambiguities which are almost sure to cause contentions and trouble during construction and in the final settlement or lead to litigation. Such engineers are apt to insert severe conditions such as excessive cash deposits with the bids, unreasonably short time in which to construct work, excessive per diem liquidated damages for overtime, excessive bonds and sometimes excessive retained percentage where monthly payments are provided, and about all they can think of to make the work undesirable and objectionable to contractors. Such engineers and their work are often avoided by the best class of bidders and the contracts go to undesirable contractors.

Incasing Steel on Rock Island Bridge at Chicago

Manner of Coating the 631-Foot Viaduct over the Chicago & Western Indiana Railroad at Seventy-ninth Street

As a protection from locomotive gases and other injurious agencies the Chicago, Rock Island & Pacific Railway is incasing all the steelwork of its 631-ft. viaduct over the Chicago & Western Indiana Railroad, at Seventy-ninth Street, Chicago. Gunite, which consists of a 1:3 mix, secured by suitable reinforcing material, is used to coat all the steel work with the exception of the top portion, which is incased by a reinforced-concrete top slab.

The protective bottom slabs between the lower flanges of the floorbeams were constructed by laying ⅜-in. square reinforcing bars on the girder flanges and covering with American Steel & Wire Company's No. 7A triangle mesh. Wooden forms were suspended 2 in. below the reinforcement by means of wires attached to the girders. The 1:3 mix was then built up from the top to a depth of 3 in. over the mesh, forming a bottom slab 5 in. thick. The flanges of the floorbeams which are covered to a depth of 2 in. are reinforced with galvanized woven wire mesh and bent ⅜-in. rods. The floorbeam webs and fascia girders are coated to a depth of 1¾ in., as are the external surfaces of the box girders over Seventy-ninth Street and four of the columns in Seventy-ninth Street over the Western Indiana bridge floor.

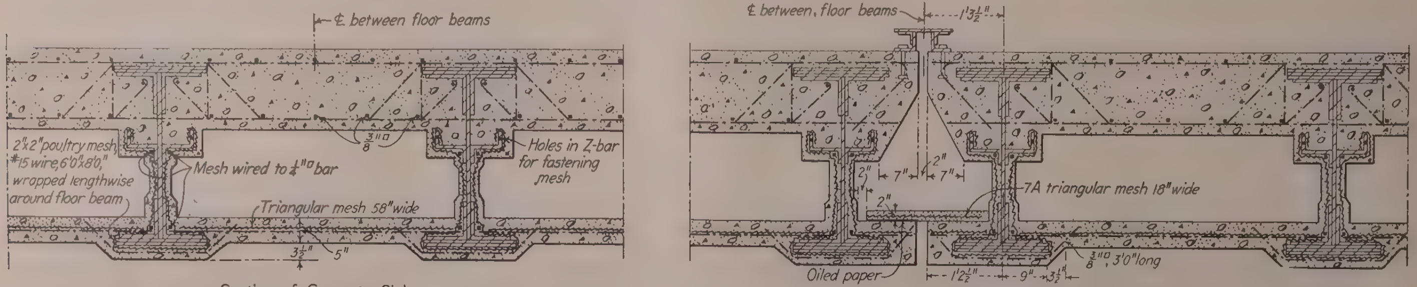


VIEW IN SECOND BAY, SHOWING METHOD OF REINFORCING

In order to facilitate the work, which had to be done from the under side of the bridge, a special elevated platform was rigged up on top of an ordinary box car. The necessary machinery for the work was placed inside of the car, while the mixing of the concrete was done on an adjoining platform car. The power for the cement gun was provided by a 12 x 12-in. Gardiner air compressor, of the horizontal type, driven by a 40-hp belt-connected electric motor. The outfit is shown in part in one of the photographs. For the work on top of the bridge the cement guns were placed on the bridge floor. The distance through which the material had to be conveyed through the hose line exceeded 300 ft. in some places. In finishing up the work the coating was applied so as to follow the outlines of the steel members, producing a panel effect.

The top slab, which will be put on last, between the flanges of the floorbeams is made of reinforced concrete with a 1:2:4 mixture. The box girders over Seventy-ninth Street were filled with a 1:2:4 mixture of concrete before being coated. The cement gun used in shooting the 1:3 mix on the structure averages, placing a depth of 2 in., from 130 to 160 sq. yd. per day.

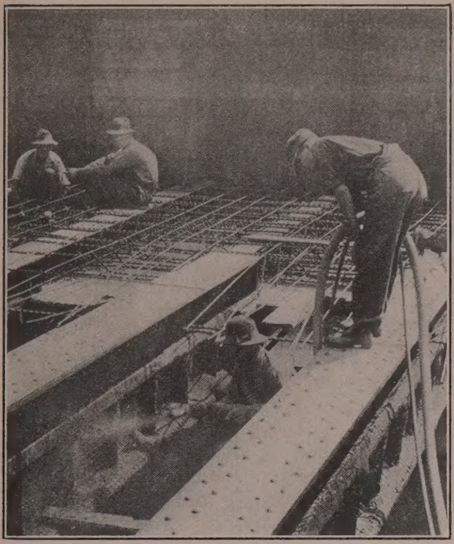
The entire structure consists of five bays on a 22-deg. skew. A 2-in. expansion joint is placed between the floorbeams, and in order to keep smoke from getting in from below, a 2-in. concrete slab was formed with the 1:3 mix. Oiled paper was placed between the incased fixed floorbeam and the slab to allow the latter to slide easily with expansion. Ballast is prevented from getting in the top of the expansion joint by means of a steel covering made up of two



Section of Concrete Slab between Intermediate Floor Beams

Section of Concrete Slab at End Floor Beams

DETAILS OF CONCRETE SLAB WORK BETWEEN INTERMEDIATE FLOORBEAMS AND AT END FLOORBEAMS



COATING THE STEEL FLOORBEAMS

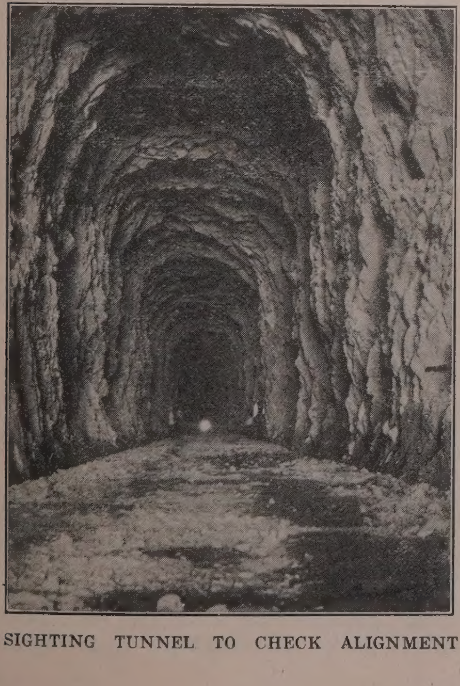
angle plates and a steel top plate. The plate is slotted on one side to allow play for expansion.

The incasing work is being done by the Cement-Gun Construction Company, of Chicago, under the supervision of R. H. Ford, engineer of track elevation of the Chicago, Rock Island & Pacific Railway.

Small Sighting Tunnel

Extension of Tangent to Check Up Alignment, Where the Main Tunnel Curved Away Near One of the Portals

THE tunnel interior shown in the accompanying view is that of Tunnel 14, 2837 ft. long, under Battle Bluff on Kamloops Lake, on the line of the Canadian Northern Pacific Railway in British Columbia. Near the far portal the center line is curved for a distance of 300 ft., and the daylight seen in the center of the bore comes through a 4 x 4-ft. sighting tunnel 300 ft. long, driven to check up the alignment. By the use of the sighting tunnel it was possible to produce the tangent sight to a point several miles distant across the lake, whence the ridge immediately over the tunnel center line could be seen clearly.



SIGHTING TUNNEL TO CHECK ALIGNMENT

Book Reviews

Units of weight and measure with definitions and tables of equivalents are presented in Circular 47 of the Bureau of Standards. The pamphlet contains 68 pages. (Washington, D. C., Government Printing Office.)

The annual report of the Department of Bridges, City of New York, for the year ended Dec. 31, 1913, has appeared recently in printed form. The book consists of 128 pages, 7 x 10¼ in., and is bound in red cloth. Besides reports on maintenance, traffic, subway connections, strengthening spans and construction of terminals of the East River bridges, the work on other bridges, such as those across the Harlem River and those in Brooklyn, Queens and Richmond, has been described. The divisions of design, construction and shops and stores have been dealt with in separate chapters. The book is well illustrated with photographs, plans and diagrams of work done and work proposed. (New York, Department of Bridges.)

"Trigonometry with the Theory and Use of Logarithms" is the title of a 142-page, 5 x 7½-in. book with 58 illustrations written by Maxime Bocher, professor of mathematics at Harvard University, and Harry Davis Gaylord, mathematical master at Browne and Nichols School, Cambridge, Mass. As a guide for teachers of trigonometry and a textbook for students this volume will admirably fill its purpose. The method of dividing the chapters in two parts, one printed in somewhat smaller type than the other, is an advantage, as it enables the teacher to give a brief course in logarithms and plane trigonometry simply by omitting the sections in small type. (New York, Henry Holt & Co., $1.)

HANDBOOK CONTAINING GENERAL INFORMATION FOR THE USE OF ENGINEERS, ARCHITECTS AND BUILDERS. By Lackawanna Steel Company, Buffalo. Leather, 4 x 6½ in.; 456 pages, Buffalo, Lackawanna Steel Co. $2 net.

(Reviewed by F. H. Constant, Professor of Civil Engineering, Princeton University, Princeton, N. J.)

This compact little book of pocket size contains 456 pages and covers much the same ground found in the handbooks issued by the other large steel companies. Its main purpose is, of course, to describe the shapes rolled by the Lackawanna Steel Company and to give their leading properties. A very useful column in the tables of standard shapes is the one giving the mill length beyond which greater lengths can be obtained only by special arrangement. Among the shapes of special interest to the engineer are those of the Lackawanna steel sheet piles.

The usual properties of beams and columns are given in complete detail. Net values of beams and channels in flexure, after deducting a hole in both the top and the bottom flanges, are given, as well as the net areas of angles after one, two and three holes of from ¾ in. to 1 in. in diameter have been taken out. The strength of columns, to which many pages are devoted, are based on Gordon's formula for square ends. Safe uniformly distributed loads for single webbed and box plate girders are given at length, as well as for I-beam and channel spans. The draftsman's work is simplified by the data covering standard connections and the tables of rivet spacing, in which, given pitch and the number of spaces, the total distance can be read.

In nearly every other respect the book covers about the same ground as the former editions of the Carnegie "Pocket Companion," which it closely resembles.

PLANE SURVEYING FOR USE IN THE CLASSROOM AND FIELD. By William G. Raymond, Dean of the College of Applied Science, State University of Iowa. Leather, 5 x 7 in.; 589 pages, 7 plates, 239 illustrations. New York, American Book Company. $3 net.

(Reviewed by A. F. Comstock, Associate in Railway Engineering, University of Illinois, Urbana.)

This is the second edition of a book which was first published in 1896. In preparing the new edition, the author has seen fit to reduce the size to pocket form, and to rewrite and rearrange much of the contents for more convenient use. Both changes have made a noticeable improvement. The number of examples and exercises has been increased, and minute details in descriptions of survey operations have been omitted. The publishers have contributed to the attractiveness of the book in several ways, especially by the use of dull paper.

There are in all sixteen chapters comprising 432 pages, and a 147-page appendix containing 107 pages of tables. The first four chapters aggregate 142 pages. They treat of the measurement of lines and angles, and the uses and adjustments of the level and transit. Chapter 5 is a rather extensive discussion of land-survey computations, embracing balancing the survey; areas, and supplying omissions. Chapter 6 briefly outlines solutions of some of the problems connected with overcoming obstacles to direct measurement. Complete descriptions of office instruments, such as the slide-rule and planimeter are contained in chapter 7. Chapters 8 and 9 deal with stadia measurements, and meridian, latitude and time. The solar transit is here described at some length. "General Surveying Methods" is the title of chapter 10, which is largely concerned with the United States public land surveys. Chapter 11 is devoted to a very brief, elementary treatment of circular curves.

Chapter 12, in 37 pages, takes up topographic surveying, mapping, and use of the plane table. In chapter 13 the simpler computations in earthwork, including railroad earthwork, are presented; and in chapter 14 there is a discussion of the more common problems of city surveying. Chapter 15 on hydrographic surveying includes such subjects as taking soundings, use of the sextant, measuring velocity and discharge of streams, and weir measurement. "Mine Surveying" is the title of chapter 16, which, in 19 pages, gives a somewhat limited discussion of the special instruments and methods employed in underground surveying.

The Appendix contains, in addition to the tables, 41 pages of text dealing with such subjects as examples in surveying by co-ordinates, judicial functions of surveyors, ownership of surveys and rules of procedure in United States public land surveys. The tables include five-place logarithms and logarithmic functions in very convenient form; stadia reductions; and other tables usually required in computations from surveys. An excellent index, followed by seven model maps and plates, completes the volume.

Essentially a text covering the elements of surveying, the book makes a pleasing impression. Much of value has been added to the old edition through rearrangement, revisions, additions and the increased number of illustrations. The book is attractively bound, and is convenient in size, although its thickness, which is approximately twice that of the ordinary field book, renders it somewhat bulky to be termed literally a pocket book.

STRUCTURAL ENGINEERS' HANDBOOK. DATA FOR THE DESIGN AND CONSTRUCTION OF STEEL BRIDGES AND BUILDINGS. By Milo S. Ketchum, C.E. Leather, 6½ x 9 in.; 916 pages; 260 tables; 400 illustrations. New York, McGraw-Hill Book Company, Inc. $5 net.

(Reviewed by R. Fleming, of the American Bridge Company, New York.)

This book is a mine of information to anyone dealing with the subjects of which it treats. The aim is clearly defined in the preface. It is intended to be a source book, not a treatise, and presupposes a knowledge of applied mechanics and the calculation of stresses. The designer and the draftsman will find data and details selected from a wide range of material, much of which has heretofore been accessible to only the few. For example, most of the chapter on erection of structural steel is now available to the public for the first time. The author in Part I includes chapters on retaining walls, bridge abutments and piers, timber bridges and trestles, steel bins, steel grain elevators, steel head frames and coal tipples, and steel standpipes and elevated tanks on towers, as well as chapters on buildings, bridges, general designing, estimating and detailing. Under Part II he gives 280 pages of tables, a number of which were calculated especially for this book.

The selection of what shall be chosen from the mass of literature on structural engineering in the compilation of a handbook depends upon the personal equation of the author. The reviewer would like to see a chapter added on steel towers and poles for electric power transmission lines, the auto truck mentioned among highway bridge loads, a method given for calculating anchor bolt stresses in standpipes and steel chimneys, and a steel head frame or coal breaker of the Pennsylvania anthracite coal region illustrated. To gain space there might be omitted one of the head frames of the Middle West, possibly the chapter on steel grain elevators, and a few of the tables.

The details of a mill-building column on page 20 show a five-rivet knee-brace connection fastened to a latticed column. This is not an unfamiliar sight, but the practice is to be condemned. The lacings should be replaced by a solid web plate. In the chapter on highway bridges a number of low truss bridges are detailed. It is presumed that the top chord has been proportioned for unsupported lateral lengths of one panel, but in some of the illustrations there is little shown from abutment to abutment that will keep the chord in alignment. With the ever-increasing loads coming on our highway bridges the pony truss is doomed. It is barred now in some specifications. In variance with the almost universal custom the author uses + to indicate compression and — to indicate tension. This variance is of doubtful wisdom. A paragraph repeated in each of his specifications provides that no material shall be ordered "until the working drawings shall have been approved by the engineer in writing." This is impracticable and seldom followed. The reviewer dissents from the author's method of calculating wind stresses in tall buildings.

However, any unfavorable opinions about parts of the book are more than offset by its many excellences. The chapter on structural mechanics is unusually complete in its formulæ for stresses in loaded beams, the method of distinguishing the tables of weights from those of areas is unique, and throughout the book references are given to authorities that may be consulted for further information. The reader will be glad to find so much that is thoroughly practical.

The typography is excellent. It is refreshing to find a full table of contents at the beginning and a good index at the end. In conclusion, no one interested in structural engineering can afford to be without this book.

Letters to the Editor

The War and the Foreign Technical Press

SIR: In the Engineering Record of Sept. 5, Current News, page 128, appeared a note entitled "The War and the Foreign Technical Press." We beg to inform you that all German and Austrian technical periodicals which come to our library have been received on scheduled dates even during the war. Your assumption that the big technical journals have been suspended is, therefore, not correct. The periodical of our society has been published without interruption and forwarded regularly to America. The reason for the reduction in the number of pages in some technical papers is that large parts of their staffs are now at the front. We regret that so far few German technical publications have arrived in America. In that respect we are better off here, as the big American technical periodicals, which we esteem highly, have been received nearly as regularly as during normal conditions. Trusting that in the near future our technical journals will also arrive regularly, we are,

VEREIN DEUTSCHER INGENIEURE,
Abt.: Literarisches Bureau,
Per C. Matschoss.

Berlin, Germany.

[The war broke out early in August, and on Sept. 5, when the note referred to appeared, the statement that the technical publications had been suspended in Austria and Germany, or that few were received in the United States, was correct. The German publications now appear practically on scheduled dates, although no Austrian publications have so far been received.—EDITOR.]

San Francisco Wharf Design

SIR:—Wharves of all-concrete design are not used to the exclusion of other types in San Francisco, and lest casual readers of the Engineering Record gain an erroneous idea on this point from an article you published recently, I would like to call attention to the facts of the case.

In the Engineering Record for October 3, under the title of "American Wharf Design" there appeared an extract of a paper read before the American Society of Port Authorities by W. J. Barney of New York. The first sentence of this article reads: "Wharf design varies greatly in different parts of the United States. The extremes are perhaps the all-timber type that prevails in New York City and the all-concrete design used in San Francisco." Later under the sub-head of "San Francisco—All Concrete" this statement appears: "The natural conditions at San Francisco are best met by the construction of the open pier all in concrete, substructure and superstructure."

As a matter of fact, some of the wharves built in San Francisco recently are reinforced concrete, some are all wood, and others include both wood and concrete construction. The waterfront in this city, which is owned by the State and managed by the State harbor commission, has to pay for its own support, and since tolls and other charges levied on shipping have to equal the cost of upkeep, it is of the greatest importance to the commerce of the port that all construction be of the most economical type, giving the least annual interest charge and maintenance cost.

Some time ago special attention was given by port authorities to a study of the comparative merits of several types of construction. Some of the semi-wooden structures of the earlier days had proved unsatisfactory and it became desirable to find a more suitable design. The writer had an opportunity to examine and compare several types of construction as engineer for the San Francisco Chamber of Commerce, acting in conjunction with R. M. Drake, division engineer of the Southern Pacific Company, and Leland S. Rosner, consulting engineer.

About this time the harbor commission, recognizing the need of an improved type of pier, prepared some all-concrete designs. Extensive reconstruction was soon afterward started on a section where there was a good hardpan foundation overlaid by a shallow mud cap—a condition in which ordinary piling would not have any lateral stiffness. The all-concrete pier was, therefore, the best type of construction for this particular foundation, but its high cost of from $2.16 (special conditions gave this low cost on one pier) to $3.50 per square foot was objectionable. Furthermore, a pier of this type is so expensive that once built the cost of tearing out is prohibitive and the floor plan must remain fixed for all time. This is a disadvantage when port authorities are constantly increasing the length and width of new piers to accommodate changing conditions. The new plan of the waterfront in no way coincides with the old, and another generation may bring an equal change.

Another objection to concrete is that on much of the waterfront where work is now going on there is no hardpan bottom, but instead soft mud of unknown depth. Concrete cylinders in this foundation would have to be supported on piles cut off well below the mud line in order to be protected from marine borers. Such work is expensive. There is left, then, the choice between wooden and reinforced concrete piles. Untreated piles have a life of from 6 to 18 months in local water. Creosoted piles have a life of about 20 years, as is demonstrated by the long railroad wharf at Oakland.

Recently a creosoted pile dock was built in San Francisco for a contract price that figured as low as $0.814 per square foot.

However, estimating the cost of a wooden dock supported on creosoted piles at $1.00 per square foot, and allowing for complete replacement at the end of each 20 years, we found that such concentration would give an annual charge of $0.1316 per square foot as against a like charge of $0.1497 for a concrete dock estimated to cost $3.25 per square foot and having an assumed life of 75 years (the term of the bonds).

From the foregoing it can be seen that the so-called temporary wooden construction is the most economical for San Francisco harbor. The engineer of the harbor commission, Jerome Newman, has revised our figures somewhat, allowing a life of but 12 years, and charging for lost revenues during reconstruction. But even with this short life the creosoted pile dock still remains cheap enough, comparatively, to warrant its use, and it has the very valuable feature of changeable floor plan. At the end of 12 or 20 years, as the case may be, the width, length and whole floor arrangement can be changed to meet the new demands of shipowners and shippers. Recently a technical journal gave an account of the tearing out of a great masonry dock in an English port. The dock was as good as new, the only trouble being that it had become obsolete as to size and could no longer dock the modern ocean liners.

There is one dock in the deep-mud section of the San Francisco waterfront which is supported on untreated piles incased in a hollow cylinder of reinforced concrete slipped over the pile and driven below the mud line. The mud and water was then pumped out and the intervening space between pile and cylinder filled with cement grout. The dock floor is of wood resting on a concrete-incased steel cap. This dock cost $2.00 per square foot. It may prove to be a very serviceable type.

HENRY A. CAMPBELL,
Engineer, San Francisco Chamber of Commerce.
San Francisco.

Bond Issues vs. Tax Levies in Paying for Improvements

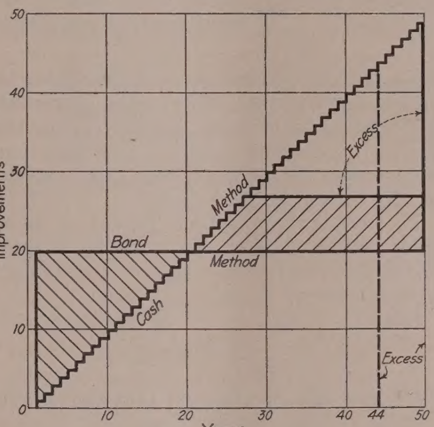
SIR: I have noted that you made mention in one of your issues (see Engineering Record of Sept. 19, page 314) at the time it occurred of the latest financial policy of the city of New York.

For some time I have been strongly advocating a method almost exactly similar to that now adopted. In this connection, a memorandum was prepared analyzing some of the arithmetical differences in the old and the new methods. A copy of such memorandum is submitted for such use as you see fit to make of it. Some of your readers may find arguments which can be modified to meet special conditions in municipalities where the old methods may perhaps still be in force.

E. P. GOODRICH,
Consulting Engineer, Borough of Manhattan.
New York City.

[The memorandum referred to by Mr. Goodrich is printed below.—EDITOR.]

Assume 5 per cent for interest and sinking-fund requirements on fifty-year bonds, and $1,000,000 available annually to finance public improvements. Then $20,000,000 could be issued in fifty-year bonds and public improvements secured immediately (assumed one year after bond issued). The interest on this $20,000,000 at the 5 per cent above assumed is the $1,000,000 also assumed as annually available. Thus twenty improvements at $1,000,000 each can be enjoyed for forty-nine years. On the other hand, if the initiation of improvements is delayed so that only one is initiated each year to the extent of $1,000,000 and cash paid therefor, improvements would be secured and enjoyed as follows: One improvement would be secured the first year and enjoyed for forty-nine years, one would be secured the second year and enjoyed for forty-eight years, one would be secured the third year and enjoyed for forty-seven years, etc. The twentieth improvement would not be secured until the twentieth year, and it would be enjoyed for only thirty years; but at the expiration of the fifty-year period, forty-nine improvements would have been secured and enjoyed on an average of twenty-four and one-half years each; while one additional improvement would have been secured during the fiftieth year. This makes a total of 1200 "improvement years."



NUMBER OF IMPROVEMENTS ENJOYED ONE YEAR BY CASH AND BOND METHODS

Amounts designated by "Excess" to be considered as alternative

In the case of the bond issue, there would have been only twenty times forty-nine equals 980 "improvement years." At the end of the fifty years, the cash method would have secured 225 additional "improvement years." This additional enjoyment would obviously have been delayed until toward the end of the fifty-year period; and the question to be answered is whether the additional delayed improvements are worth more than the immediate enjoyment of a less number of improvements.

Total expenditure for improvements by bond method	$20,000,000
Total expenditure for improvements by cash method	50,000,000
Total payment by taxpayers, each method	50,000,000
Interest paid to bankers, bond method	30,000,000

It is often stated as against the cash method that a tax-payer has the use of his money in his own business during the fifty-year period; and that when he pays cash for an improvement he is thereby deprived of certain profits which he might have made. Assume 5 per cent for interest and sinking fund on fifty-year city bonds, and assume that an individual taxpayer's share of an improvement is $100. Obviously his share of the interest and sinking-fund requirements would be $5 per annum over a period of fifty years. In other words, he would have the use of $95 of his income compounded over that period. On the other hand, if he paid $100 cash the first year, he would have the use of $100 of his income compounded annually for forty-nine years. The accumulations at the end of the fifty-year period are easily computed mathematically by well-known actuarial methods—the formula being $S[(1+r)^n - 1]/r$, where S is the annual sum involved, n is the bond period and r is the interest rate measured in hundredths.

Making these computations on the assumption that the taxpayer can compound his money at the 10-per cent rate per annum in each case, the problem resolves itself into $95 compounded for fifty years against $100 compounded for forty-nine years. The totals in the two cases are, respectively, $110,572 and $105,720. There is a difference, therefore, in favor of the bond method as far as the taxpayer is concerned of $4,852 accumulation at the end of fifty years. This is a matter of only four and a fraction per cent, which is to be offset against the enjoyment of a greater number of improvements where cash is paid for them.

In this connection it is to be recalled that the majority of taxpayers are wage earners or salaried employees, and that few of them have opportunities or the ability to compound their savings at any such rate of interest. To the large majority of taxpayers, therefore, the problem is not one of a 10-per cent compounding, but only the interest which savings banks will pay on deposits, or which may be realized from absolutely safe investments, such as are always recommended for the man with small earning power. If the above computations are made on the basis of a 5-per cent compounding, the results are, respectively: $19,888 accumulations if bond method is used, against $19,843 if cash is paid for the improvement. This is an insignificant item. Even in the case of a 20-per cent compounding, the taxpayer would have accumulated at the end of fifty years only about 12 per cent more than had cash been paid.

Assume a 10-per cent limit of bond indebtedness for the municipality, a 2 per cent limit in the tax rate for such municipality, and assume 5 per cent as the interest and sinking-fund requirements on fifty-year municipal bonds. With a valuation of 1,000 the bonds outstanding would amount to 100. The eventual interest and sinking-fund requirement would be 5, while the total taxes would be 20. In other words, 25 per cent of the total tax rate would go for interest on indebtedness. The other 75 per cent would normally be expended for general municipal administration. If it be assumed that the full limit of indebtedness is maintained at all times, so long as the municipality is growing at a constant rate per annum (geometrical ratio), improvements can be made through and paid for by bond issues to the extent of 10 per cent of the yearly increase in valuation. Should this increase stop for any cause, public improvements must similarly cease. Under such circumstances no increase can be made in the tax rate for improvements or for increase in cost of administration. In other words, the municipality is absolutely estopped from developing itself so as to bring about an increase in valuation through the effect produced by public improvements. It has throttled its own growth.

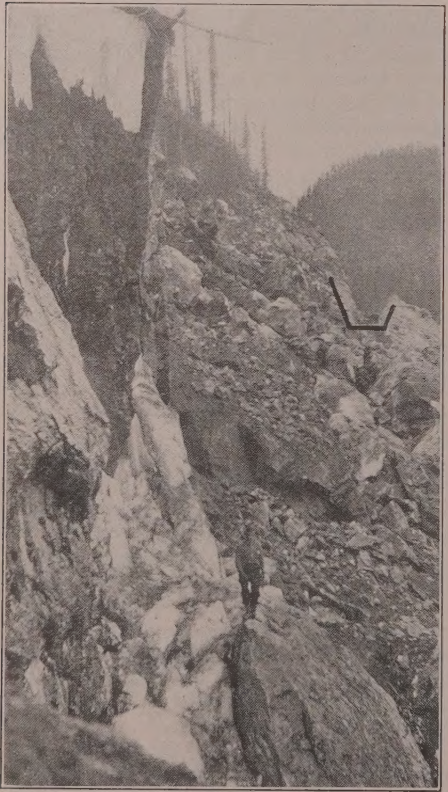
Had the "pay-as-you-go" method been adopted, more improvements could have been secured in any period longer than that measured by the bond interest rate divided into 100 and any time the community would have been in a position to expand or contract its tax rate (within the assumed 2 per cent limit above mentioned) as community demands required. An elastic method would have been secured with the corresponding beneficial result.

Difficulties of the Railroad Contractor in British Columbia

SIR: The troubles of the railroad contractor are ever legion and as varied as they are numerous, yet I believe the construction of the Canadian Northern Railway through the canyons on the Fraser and Thompson Rivers presented more new problems than any of the other lines recently built in the West. The fact that the cost of the 500 mi. of the road within the borders of British Columbia averaged about $75,000 per mile tells only the financial side of the story, and even so, railroad builders are agreed that for the low gradients secured this average cost is extremely low.

However, in addition to the engineering questions involved in this work there was also the "human side"—the side that has to do with keeping crews at work under extreme weather conditions, striving to maintain contentment in a camp to which mail and supplies come only once a month, and encouraging among men on disheartening work the esprit de corps without which the average cost would have been even greater.

In the Engineering Record of June 6 there appeared a comprehensive description of construction on this line, and it occurs to me that the two photos I am sending herewith may be of further interest. The view of the sidehill was taken in the canyon of the North Thompson near a point known as Hell's Gate, where solid-rock excavation was continuous for 5 mi. The cut under construction is marked in the background, while the foreground gives a good idea of the character of the country to be traversed. The final location surveys, made along the face of ice-covered cliffs of this sort, can be imagined better than described, yet the fatality was surprisingly low.



DIFFICULT SIDEHILL LOCATION

A "ONE-HORSEPOWER HOIST" ON THE CANADIAN NORTHERN

The other photograph shows a horse being hauled back to the grade by twenty-six men, after it had fallen some 30 ft. without injury.

Victoria, B. C. K. T. ROBERTS.

Rational Methods and Guesswork in Sewer Design

SIR: Your editorial in the Engineering Record of Oct. 17, page 420, prompts me to call your attention to the discussion of the storm-water flow problem in my paper on the San Francisco sewer system, read several years ago before the American Society of Civil Engineers. (See "Transactions," Vol. LXV, page 292.) A theoretical demonstration is there attempted of a simple rational formula which eliminates practically all uncertainties except those which relate to the time required for water to flow to the gaging point and those which are due to the character of the surface of the watershed.

In the discussion of a paper recently submitted to the American Society of Civil Engineers by C. B. Buerger I took occasion to call attention to the fact that the element of greatest uncertainty in applying any formula for the determination of maximum storm-water flow will always be the factor based on the relative imperviousness of the surface of the watershed. The approximation of this factor for any particular case is largely dependent upon the judgment of the engineer, based on such facts as have come to his knowledge. This being the case, it seems self-evident that complicated formulæ should be avoided and that those should be adopted which in some simple way introduce the intensity of rainfall, suitably modified according to topography and surface characteristics.

The type of formula generally used to express rainfall intensity is

$$I = CR/(20 + t)$$

where C is a coefficient to be determined for any locality from the rain records; R, maximum rainfall in that locality in one hour, expressed in inches, and I, the intensity of the rain during t minutes, expressed in inches per hour. Unfortunately this formula or any of the type $I = C/(t + b)$ is not suitable for use except for time periods but little in excess of one hour, and its use should be discouraged.

Several formulæ have been recommended by the writer, of which the simplest and best for general use is:

$$I = C/\sqrt{t}$$

If this be used, the maximum storm water flow q expressed in second-feet per acre is given by the formula

$$q = 5\ a\ R/\sqrt{t}$$

or

$$q = 0.645\ a\ I$$

In these formulæ a is the coefficient of imperviousness and t is the time in minutes required for the concentration of water from the watershed at the gaging point.

With rational formulæ as simple as the above there is no need for guesswork, even though the formulæ for lack of data on which to base a selection of the value of a and of t are to be regarded only as more or less reliable approximations. But the very fact that even the best formulæ can only supply approximate information in regard to required capacities when the sewers carry storm water makes it desirable to provide some safety margin if this can be secured at reasonable cost. This is desirable, first, because the judgment of the engineer due to misinterpretation or lack of data may have been at fault, and, second, because it is always to be assumed that the heaviest rainfall of the past will some day in the future be exceeded.

When the use of sewers is restricted to sanitary sewage alone, closer estimates required of capacity can be made and there is less need for a safety margin. At the same time even here the nature of future development cannot always be foreseen with certainty and good ground may be found for giving the sewers some excess capacity. This is good practice, particularly as the departure of the flow at the peak from the mean for the day can only be approximated and the capacity must be adequate even for the hour of maximum flow.

C. E. GRUNSKY,
President, American
Engineering Corporation.
San Francisco.